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COAL-DUST FUEL.

WHEN coal is burned in large lumps a certain amount of power is expended in the furnace in disintegrating the fuel. This is, however, comparatively a small matter. But it is obvious that difficulties are thrown in the way of the union of the carbon with the oxygen of the air, and it has come to be recognized as a feature of good stoking that the coal should be broken into moderately small pieces before it is put into the furnace, and that the process of firing should be as continuous as possible. The great advantage derived from the use of mechanical stokers lies no doubt in the almost perfect fulfillment of the last-named condition. If we carry the idea a little further, the use of coal in a state of powder will suggest itself; and as it is impossible to feed a fire satisfactorily by hand with coal-dust, it has come to be understood that it should be blown into the furnace with the air required for its combustion, which is thus intimately mingled with the carbon. Until a very recent period this system was only used by Mr. Crampton, whose well-known revolving puddling furnace is supplied with powdered coal by a fan blast, the coal being first ground very fine between an ordinary pair of millstones. We believe that at one time Mr. Crampton applied this system, but without success, to a steam boiler. We are not in possession of any of the details of this experiment, and so we can say nothing about the cause of failure. In 1876 a series of trials was conducted by the American Government to determine the value of a system of burning powdered fuel, patented by Messrs. Whelpley and Storer. The boiler was 40 in. diameter and 10 ft. long, and almost precisely similar in every respect to one illustrated in our impression for May 4th, page 310—that is to say, it was a plain cylinder externally fired, the products of combustion returning to the front end through 74 tubes 2¼ in. diameter outside; the total heating was 442 square feet. The air required for combustion was delivered into the closed ashpit, vertically, through a pipe 5 in. diameter. The powdered coal was sent in through a pipe 2 in. diameter, arranged horizontally. The boiler was tried both with powdered anthracite and lump anthracite, the only change made as regards the boiler consisting in the removal of a brick arch used with the dust fuel. This increased the heating surface to 457 square feet. Each experiment lasted forty-eight hours. Four experiments were made; two with lump coal alone, and two with lump coal supplemented by dust coal below or above it.

Calling the experiments with lump coal alone A, and those with dust coal C and D, the results may be briefly stated as follows: In experiment A, 11·113 lb. of lump coal were consumed per hour per square foot of grate surface, with 80·478 double strokes of the piston of the engine supplying air; the resulting vaporization per pound of the combustible portion of the coal was 10·124 lb. of water from the temperature of 212 deg. Fahrenheit, and under the atmospheric pressure. The mean rate of combustion in experiments C and D was 11·350 lb. of the combustible portion of the coal consumed per hour per square foot of grate surface, with 79·748 double strokes per minute of the piston of the engine supplying air, the resulting vaporization per pound of the combustible portion of the coal being 10·192 lb. of water from the temperature of 212 deg. Fahrenheit, and under the atmospheric pressure. The two economic results—namely, 10·124 and 10·192—are almost identical, and show, when semi-bituminous coal is burned at the same rate of combustion, with the same *pro rata* air admission, and under the same circumstances, it gives the same economic vaporization, whether it is consumed wholly in the lump state, or partly in the lump and partly in the pulverized state, or wholly in the pulverized state. The equality of economic result is also proved by the fact of the equality of the temperature of the gases of combustion in the comparable experiments when leaving the boiler. In experiment A, burning lump coal alone, this temperature was 383·30 deg. Fahrenheit, while the mean of the temperature of the gases of combustion in the boiler-uptake during experiments C and D, during which partly lump coal and partly pulverized coal were consumed, was 381·85 deg. Fahrenheit. This comparison is made, however, for the heating effects alone of the coal in the two states, burned under the same circumstances, and is exclusive of the cost in fuel of pulverizing the coal, and of blowing the dust into the furnace. A correct commercial comparison must include this cost, which is only incurred when the coal is used in the pulverized state, because when it is used in the lump state it can be burned as rapidly with the natural draught as the pulverized coal can with the artificial draught obtained by the fan-blowers. The reason why the pulverized coal cannot be consumed at a greater rate with the fan-blowers than the lump coal can be consumed with the average draught given by the boiler chimney is, that the former requires a certain time for ignition and combustion, which is much longer than the latter requires, because the temperature to which the former is exposed above the bed of incandescent fuel on the grate-bars is much less than the temperature of that bed to which the latter is exposed. The cost of the net horse-power in average practice may be taken at about 4 lb. of coal per hour. Now, the mean of experiments C and D gave 1·381 net horse-power developed by the engine in pulverizing the coal and in blowing the dust into the furnace, and in pumping the feed-water into the tank, which, at 4 lb. of coal per hour per horse-power, is 5·524 lb. of coal per hour, or, as the coal consumed per hour was 66 lb., 8·37 per cent. of the total weight of coal burned. Consequently, the pulverized coal was commercially 8·37 per cent. inferior to the lump coal. In experiment A, during which lump coal was burned alone, there was required to drive the fan-blowers and to pump the feed-water ·500 net horse-power, which, at 4 lb of coal per hour per horse-power, required 2·000 lb. of coal per hour to produce it, and as the hourly consumption of coal during that experiment was 66 lb., there were consumed in producing the artificial draught and in pumping the feed-water 3·06 per cent. of the total weight of coal burned. Deducting this 3·06 per cent. from the 8·37 per cent. as given in the immediately preceding paragraph, there remains 5·31 per cent. of the total weight of coal consumed applied to the pulverization of the coal alone.*

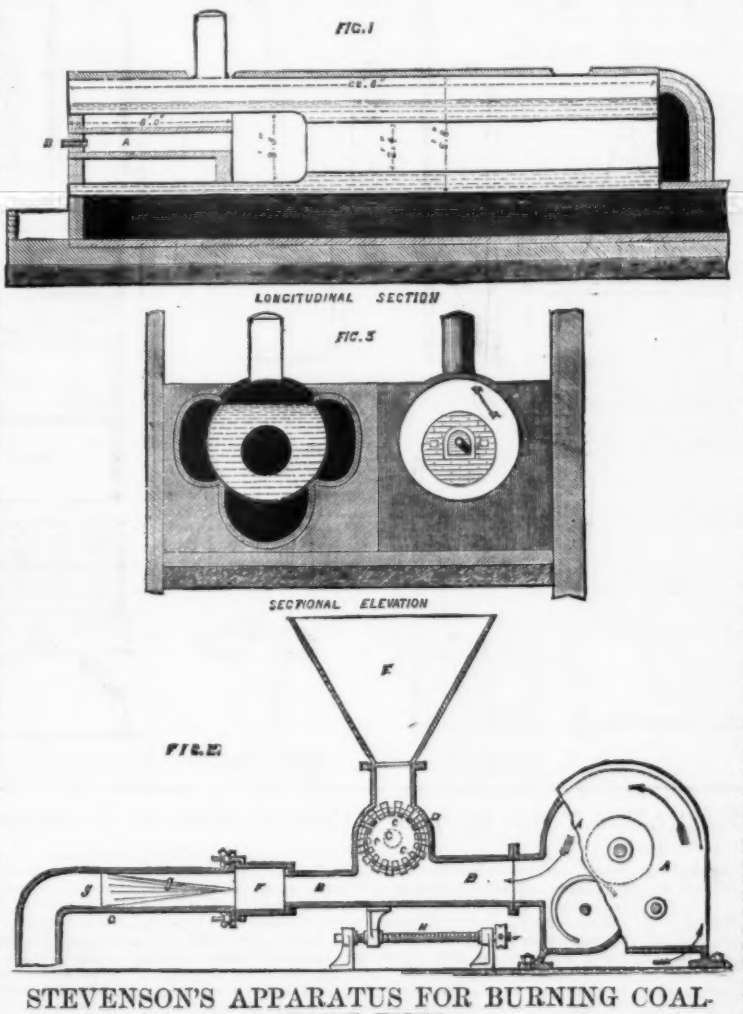
From this it will be seen that the use of powdered fuel was more expensive than that of lump coal, about in the ratio of the cost of pulverization, and so far the scheme was a failure. As regards the details of the apparatus used our information is meagre. Mr. B. F. Isherwood, by whom the experiment was made, thus comments on it: "The lump coal is first reduced by a patented apparatus (which is the only portion of Messrs. Whelpley and Storer's process that is patented or patentable) to the state of impalpable powder, and it is then fed, together with air, through a conduit to the central portion of an ordinary centrifugal or fan-blower, whose revolutions draw it in and drive it through another conduit, which discharges it into the front of the furnace through an air-tight aperture. The lump coal is fired in the usual manner, through the furnace-door, and the air for its combustion is supplied by another fan-blower delivering into a closed ash-pit beneath the grate-bars. The whole combustion is therefore effected by artificial draught depending on mechanism; and the force of this draught is easily regulated from the least to the greatest desirable in burning coal; it can also be distributed at will, so as to preserve within certain limits any required proportion between the weights of lump and dust coal consumed in the same time The two fan-blowers, in the experiments described, were operated by the same steam engine which effected the coal-crushing and worked the feed-pump of the boiler. The patentees imagine that, compared with the combustion of lump coal, a more nearly perfect combustion was to be obtained with impalpably fine coal-dust mixed thoroughly with and suspended in air, thereby presenting to the latter, for a given weight of coal, an immensely greater surface than in the lump state. They imagined, too, that, from the same cause, a much higher rate of combustion would be obtained than was probable with lump coal, by which means a boiler with a much smaller grate-surface, but with the same heating surface, would furnish with the coal-dust the same quantity of steam in equal time, and with greater economy of evaporation per pound of fuel than with the lump coal. It was to determine the truth or error of these assumptions that the experiments were made. They were intended to have been very extensive, embracing anthracite and coke as well as bituminous and semi-bituminous coals; and also a species of exceedingly hard anthracite found in Rhode Island, which contains about 40 per centum of incombustible mineral matter, and is worthless, from its difficulty of ignition and slowness of combustion, for burning in lumps. The results from different rates of combustion and different proportions of dust to lump coal consumed in equal time, were likewise to have been ascertained, but the experiments were prematurely closed, as the Government could not longer dispense with the services of the naval engineers making them."

The obvious defects of the scheme were, that the coal could not be burned fast enough, and it is instructive to note that the cooling down of the furnace of the boiler was one principal factor in bringing about this result.

For some time past an apparatus for burning coal-dust, the invention of Mr. G. K. Stevenson, of Valparaiso, has been at work in Wellington street, Blackfriars. This apparatus overcomes, it would appear, the objections urged against Messrs. Whelpley and Storer's plan, and deserves attention from engineers. The apparatus is illustrated in the accompanying engravings, and may be briefly described as follows: The boiler used is one of two precisely alike, placed side by side, as shown. They are Cornish boilers, with a single flue in each, and are of the dimensions shown in the drawing. Confining our attention to that to which Mr. Stevenson's invention is affixed, it will be seen that the grate-bars are removed, and in the furnace is placed a species of fire-clay retort, the sides of which are perforated with numerous holes, about ¼ in. in diameter. The air and powdered fuel are driven in together through the pipe B, which is 6 in. in diameter. A few fire-bricks are arranged in the flue, behind the retort, to act as a bridge.

The coal is reduced to a fine powder by a small disintegrator, which delivers into a closed sheet iron tank to prevent the escape of dust. It is brought to the condition of a somewhat coarse powder, and is not impalpable. The appliances in use in Wellington street are, in many respects, makeshift, and the powdered fuel is conveyed by hand to a hopper, E, Fig. 2. In the base of this hopper is a small delivery wheel C, in the rim of which are notches *c c*. These notches are provided with slides worked by a very simple arrangement, which compels them to obey the action of gravity and fall to the bottom of the notches when they are at the top of the wheel C. The notches then fill with coal-dust, and, as the wheel revolves, the slides, being thrust downwards, push the coal out of the notches into the air tunnel B B. The rate of delivery of the coal can thus be accurately fixed by regulating the speed of the wheel C, which is driven by a face friction wheel, in a way that will be readily understood. By setting the friction wheel nearer or further from the axis of C, the speed of the latter can be altered without affecting that of any other portion of the apparatus. In order to mix the coal-dust with the air, a twisted plate of metal, *g g*, is put in the air tunnel. This causes a rotary motion in the current, and produces the required effect. B B is prolonged into the firing place, and coupled on to the pipe B, Fig. 1, by a socket. The air is supplied by a blower A A, Fig. 2, driven by a belt from a lay shaft. The apparatus is started by lighting a fire in the retort A, Fig. 1. After this has burned up, if steam be available, the blower is set in motion and coal-dust and air fed into the retort, the front of which is bricked up, as shown in the end view of the boiler, Fig. 3.

Several experiments have been carried out to test the value of the apparatus. One by Mr. T. B. Jordan, of Queen Victoria street, lasted 5 hours 55 minutes. The boiler evaporated 5984 lb. of water from 81 deg. with 720 lb. of coal, or 8·312 lb. per pound of coal. In a previous experiment, lasting 5 hours, the same boiler fired in the ordinary way evaporated 10,194 lb. of water with 1568 lb. of coal, or at the rate of 6·501 lb. per pound of coal. In a third experiment, made by Mr. G. Barker, of Birmingham, the trial lasted 5 hours 53 minutes; 720 lb. of coal were burned



STEVENSON'S APPARATUS FOR BURNING COAL-DUST FUEL.

** Vide* Annual Report of the Chief of the United States Bureau of Steam Engineers for 1876.

and evaporated 5984 lb. of water, or at the rate of 8·312 lb. per pound of coal from fuel at 81 deg., the pressure being 42½ lb. In an experiment with the same boiler, hand fired, the evaporation was 6·5 lb. per pound of coal.

More recently we carried out ourselves an experiment which lasted two hours. The boiler was filled up to begin with, and the experiment commenced when the pressure was 44 lb. During the run no water was fed into the boiler. After it was over the donkey was started and the boiler pumped up to the same level as at starting. The stop-valve being closed, the pressure rose, notwithstanding the feed—a result due to the intense heat of the clay retort and fire-bricks. The whole quantity of water evaporated was 35 cubic feet, or 2184 lb. The weight of coal burned was 176·5 lb., and it follows that 12·3 lb. of water per pound of coal were evaporated from and at a temperature of 291 deg. It will be seen that the rate of evaporation was extremely low for so large a boiler, and it is proper to add that the blower, which ran at an average speed of 260 revolutions per minute, was driven by a lay-shaft running too slowly, but over which Mr. Stevenson had no control. The speed also varied considerably, which was against the performance of the apparatus. Throughout everything worked perfectly without a hitch or difficulty of any kind; and the closing of the boiler front rendered the firing place exceedingly cool—a manifest advantage.

A curious feature of Mr. Stevenson's apparatus is that the quantity of air admitted per pound of coal admits of accurate determination. During the trial at which we were present the blower supplied 1·2 cubic feet of air per revolution. This was determined by measuring the capacity of the blower, and checking the result with a delicate anemometer, placed at the mouth of the coal delivery pipe, the coal being shut off. Now 1·2 × 260 = 312 cubic feet, or 24 lb. of air per minute. The coal supplied in the same time was 2 lb. nearly. Thus only 12 lb., or the least possible quantity of air which will suffice for combustion, were supplied. Yet there can be no doubt that no smoke was produced, nor does it appear possible that any coal-dust was deposited unconsumed in the flues.

We have endeavored to place our readers in possession of all the available information concerning a new and important branch of physical inquiry. It can be easily shown that in theory, at all events, the combustion of fuels in the form of dust ought to be attended with excellent results; and Mr. Stevenson, at all events, proved that an apparatus can be made which will work without giving any trouble, and which is inexpensive and simple. But we have, on the other hand, no data concerning the cost of breaking the fuel, and the apparatus is quite too small, or at least is run too slowly, to enable any estimate of its value to be formed which can be based on fact and not on conjecture. The retort used by Mr. Stevenson is far too small, and consequently does not fit the flue properly. The retort must reduce the efficiency of the heating surface to some extent, as it is certainly not as hot as a furnace would be. It appears to be proved by the facts which we have placed before our readers that a retort, or its equivalent, cannot be dispensed with, and it is shown that a chemical equivalent of air will suffice to produce combustion without smoke. This last is an important fact, and would, standing alone, entitle the invention of Mr. Stevenson to consideration.—*Engineer.*

THE KIND-CHAUDRON PROCESS FOR SINKING AND TUBING MINING SHAFTS.*

By JULIEN DEBY, C. E., of Brussels, Belgium.

THE principal tools used in boring mining shafts by the Kind-Chaudron process are the following: The trepans, the object of which is to disintegrate the rock by concussion. These are attached to the extremity of series of wooden rods with iron armatures and screw ends, fastened to the extremity of a balance or striking beam, put into motion by means of a single-acting or bull-engine worked by hand.

Sand buckets, which are large plate iron cylinders with valve bottoms and handles, which allow of the dumping of their contents, are made use of to dredge the dirt and slush from the bottom of the shaft as the work progresses.

Shafts are bored by the Chaudron process in two and occasionally in three successive operations. The first bore is made by the small trepan, generally about 4½ feet in diameter, through which the detritus is extracted until the final completion of the shaft. This first bore is then widened by the use of the large trepan.

The apparatus employed in case of accidents or of special emergencies comprises a safety-hook, a grappling forceps of of very ingenious construction, and the fanchere (fangsheere) or holding nippers.

The small trepan is formed of two distinct portions—the blade and its stem. The first is made of a solid block of forged iron, into the lower portion of which are inserted a a number of steel or of chilled teeth of a wedge-like shape, held in place by conical keys. The stem is attached to the blade by another set of strong keys, and to the suspension appliances by means of a sliding box. This last is a very important part of the apparatus, as without it the violent vibrations transmitted by the concussions of the trepan on hard rock would inevitably rupture the connecting rods at every blow. The weight of the small trepan varies according to the work to be done; that on exhibition at Philadelphia this year weighs 15 tons. In trepans at first constructed by M. Kind the upper portion of the central stem was threaded to receive a screw which united to the slide, but this arrangement gave much trouble and soon got out of repair, and has subsequently been replaced by an adaptation consisting of two plates keyed permanently to the stem, replacing the male portion of the older model. The large trepan, employed for widening the bore made by the small trepan, consists also of a ponderous forged iron blade, carrying teeths at its two extremities, and a V-shaped guide, of the diameter of the small bore, situated in the central or toothless portion. The blade is united to the central stem by three arms strongly keyed. The weight of this tool as made at present is about 25 tons.

The whole apparatus employed in sinking and tubing a mining shaft by the Chaudron process is operated by means of two engines, the one destined to raise the trepans during the act of striking, the second to work a capstan which is used in the lifting and lowering of the various tools and of the tubing.

We refer practical engineers for minuter details to M. Chaudron's able papers entitled "*Fonçage des puits a niveau plein*," published in the Annals of Public Works of Belgium, and limit ourselves to the reproduction of drawings of the apparatus used:

Fig. 1. Sand-bucket or dredging apparatus.

Fig. 2. Safety-hook for lifting the trepans and their connecting rods in case of rupture of these last.

Fig. 3. Grappling-hook for extracting blocks of rock, detached teeth from the trepans, etc., from the bottom of the shaft.

Fig. 4. Fanchere, replacing the safety-hook in the event of a rupture of the main stem, or of that of one of the rods below the prominent collar at its head.

Fig. 5. Small trepan used at L'Hopital for the first bore of 1·37 meter diameter.

Fig. 6. Small massive trepan for the same purpose, but in hard rock.

Fig. 7. Widening trepan with a double blade, used in the air shaft for a diameter of 2½ meters.

Fig. 8. Large trepan for hard ground.

g.g. Central guide occupying the bore previously made by the smaller tool, and maintaining the apparatus in a central position.

Fig. 9. Large trepan for boring diameters of from 4·10 to 4·25 meters.

Fig. 10. Large trepan, made by adding a blade to trepan No. 7.

Fig. 11. New form of trepan proposed by M. Kind for diameters of 0·70 to 1 meter through hard rock.

Fig. 12. Trepan for a first widening of the shaft to 2½ meters in diameter.

Fig. 13. Large trepan shafts of 4·20 meters in diameter, with teeth arranged on an incline so as to direct the débris of rock to the center.

Fig. 14. Small trepan for bores of 1½ meter in soft ground.

Fig. 15. Large trepan for widening the above in soft ground.

Fig. 16. Kibble for receiving débris, proposed to be suspended in the shaft during the work of widening.

Fig. 17 Vertical section of the moss-box as fitted to the tubing of shaft No. 2 of L'Hopital.

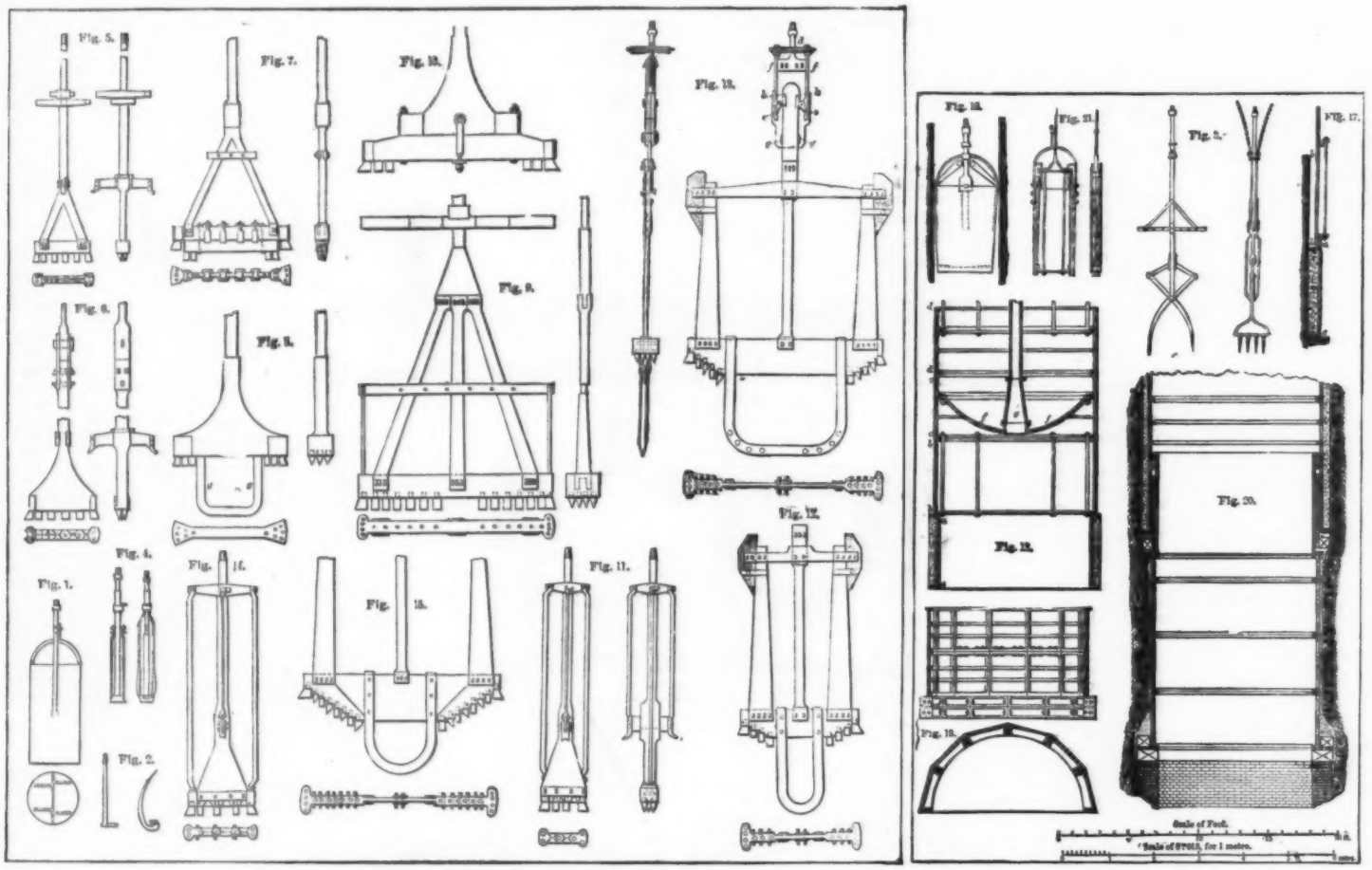
a.a. Internal cylinder, carrying a flange at the bottom, forming the wall of the moss-box. This cylinder is suspended by means of six screw bolts, which allow of its gliding on them as guides during compression.

b.b. First section of the tubing, which carries an outer flange and forms the other wall of the moss-box.

s.s. Iron (sheet) segments, which press on the moss and prevent exclusive vertical compression of the same.

m. Moss contained in the joint before compression.

Fig. 18. Assemblage of the parts which constitute the lower end of the tubing. This portion alone is lowered to the surface of the water before the series of rings of the tubing are adapted successively to it.



APPARATUS USED IN THE KIND-CHAUDRON PROCESS.

a.a. Internal wall of the moss-box.

b.b. First section of the tubing, forming the outer wall of the moss-box.

c.c. Second section of the tubing, which carries the false bottom and eventually floats the whole column.

d.d. Third section of tubing, with the suspension flanges which attach to the guide rods for the maintenance in a vertical position while sinking.

f.f. Central pipe, adapted by its lower end to the false bottom, and which is carried to the top in successive lengths along with the outer tubing; water being allowed to penetrate by means of suitable cocks inserted at various heights in this tube, permits of the gradual and simultaneous lowering of the whole casing independent of its weight. When this has reached the bottom, and the moss box has closed by compression, the water is pumped out of the shaft, and the false bottom and central tube extracted, after which the permanent foundations are established. Before, however, the water is taken out of the shaft, a coating of concrete is introduced between the tubing and the outer walls of the shaft, and permitted to harden there. The shaft is now found to be perfectly tight in all its parts, if the work has been properly conducted.

Fig. 19. Foundation for the tubing as established at L'Hopital.

Fig. 20. The same for the shaft of Sainte Barbe.

Fig. 21. Special ladle for the introduction of the concrete. This tool is furnished with a movable bottom, connected to a piston rod in such a way that pressure on the latter causes the evacuation of the contents.

COST OF SINKING SHAFTS BY THE KIND-CHAUDRON PROCESS.

The expense of sinking shafts by the system we have described is always lower than by the ordinary method of mining in all cases where the use of at least two pumps or a

* A paper read before the American Institute of Mining Engineers, at Philadelphia meeting, June, 1876.

diameter of 0·55 meter would be needed in the latter case, but it varies according to the nature. The duration of the operation is considerable prolonged whenever the soil is of a very crumbling or running nature, or in cases where it is exceptionally hard and tenacious.

Under the best conditions the cost of sinking and tubing a shaft by the Chaudron process may be set down as 2,500 francs (about $500 gold) per meter on an average for a diameter of 12 feet, and has never in the worst cases exceeded 4,000 francs (about $800 gold) as a maximum. For a width 15 feet we may safely estimate on a minimum cost of 4,000 francs ($ 800 gold) per meter, and not to exceed 6,000 francs per meter ($1,200 gold) as a maximum.

The occurrance of shifting sand or gravel, or of loose clay or quicksand, is always a cause of supplementary expenditure, as it may render the use of a certain amount of protective or temple tubing indispensable.

THE BEST FOOT WALK PAVEMENTS.

AT a recent meeting of the Association of Municipal and Sanitary Engineers and Surveyors at Ipswich, Eng., Mr. E. Buckham, C. E., Borough Surveyor, Ipswich, read the following paper:

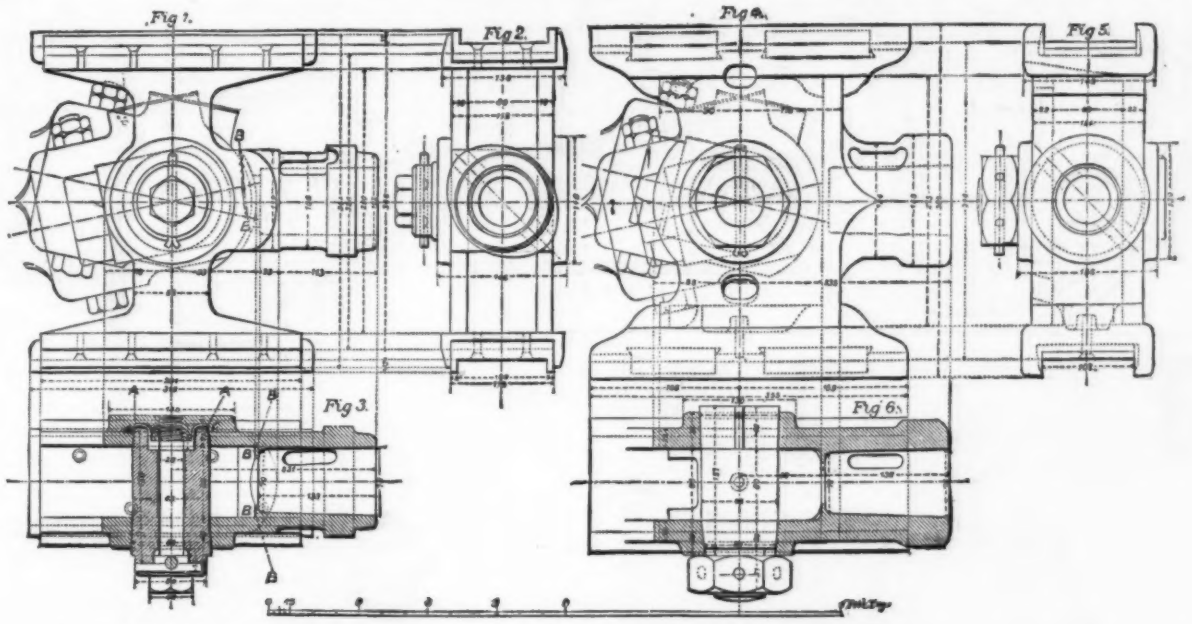
In Ipswich the mileage of footways in proportion to the population is very large, the population being 46,000, the distance of streets and roads being about 75 miles. Of this about 22 miles are town streets; and double this distance would represent about the length of paths. Formerly all the suburban paths, as well as the majority of those in third rate streets, were made with gravel. These, however, were always in a defective state. To prevent mud accumulating in winter, shingle was put on the surface. This shingle in summer time was disintegrated, and laid on the surface as though it had been strewn with peas or beans. To avoid this, loamy gravel was put on. Then, again, in winter this worked up into mud, and again had to be covered with shingle, and so on alternately winter and summer. The defects gave rise to continuous complaints, and having had experience of tar pavement in other towns I was induced to recommend it as a substitute for gravel. My suggestion was approved by the authority, and specimens of the pavement were laid, the first being done by contract at 1s. 3d. per superficial yard and maintained in repair for five years. This was thought to be too much, and the sanitary authority decided to make their own. I have prepared the material in different ways, sometimes using simply coal tar; at others, refined tar, and occasionally small portions of pitch, lias lime, and Portland cement in the prepartion of it. But in practice (although I use mainly refined tar) coal tar is all that is required, and will make as good a path as with refined tar, or any other admixture. I have two ways of making tar pavements in this borough. One is with shingle—that is, fine gravel; and the other with slag, which is clinkers and refuse cinder dirt from factory furnaces. The process of making with shingle is simple, and is as follows:—A fire is made on the ground and covered over with shingle; when this first covering is heated through more is added from time to time until there are about 10 or 15 tons. For convenience in sifting over the stuff after it has been heated through, it is desirable that the fire should be of an oblong shape, presenting a form something like the mounds under which potatoes or mangold are stored in a field. After the whole has been sufficiently heated to take out the natural moisture, it is sifted, the fine being placed in one heap and the coarse in another; when about one barrow load of each has been sifted, boiling tar is thrown upon each of them while in a hot state, the whole is then turned over with shovels and thoroughly mixed. The coarse forms the bottom layer of the path, and the fine the top surface. After a path has been made about 10 days it is dressed over the surface with boiling tar and sharp sand or ashes left from the heap of stone after burning. The sand combines with the tar and fills up the small interstices and produces a smooth surface. In making those pavements from slag it is not necessary either to heat the material or boil the tar. The material collected is turned over so that all the large clinkers are broken into small pieces, after which the whole is sifted over to separate the large from the small, and is then mixed with cold tar (unless the weather is very cold, when it is warmed to make it mix more readily). The material made in this way is laid down in the same manner as described for shingle, but is not dressed on the surface with boiling tar and sand, being better without, but it is covered with a copious sprinkling of white Derbyshire spar, which is well rolled into the top layer to relieve the dull sombre appearance and give it a pleasing effect. In laying the paths care should be taken to roll the ground well, and bring it to a uniform surface before the bottom surface is laid on, to avoid uneven or soft places, which, if not provided against, would result in the path, after being laid down for a time, having a series of undulations on the surface; in laying, each layer should be well rolled with a roller of about 7 cwt. The bottom layer should be 1½ in. thick, and the top one 1 in. It is advisable to keep the prepared stuff a few weeks before it is laid down, and although the work can be done in almost any season, spring and autumn are the most suitable, when it is dry and not too hot. Shingle tar pavements require dressing over with boiling tar, and covering with sharp sand from time to time to preserve the surface, which, if not dealt with in this way, would become rough by reason of the softer material wearing from between the joints of the stones. The material does not always turn out equally well; sometimes a path will not consolidate, and at another time the surface will break up without any, as far as can be seen, apparent reason. The shingle tar pavement costs 9d. per superficial yard laid complete, and that made from slag 11½d. Preference is given here to those made of slag, but are more costly in the first instance and less durable than those made with shingle, which can easily be understood when the nature of the material is considered; in the first instance we used shingle entirely, but from favorable reports of the Sheffield paths, and from a personal examination, and from the easier mode of preparation, I was induced to adopt that plan. I believe the Sheffield paths are better than those in this town, and I have no doubt it arises from the fact that the material is of a more durable character than can be procured in Ipswich. The costs of these pavements vary according to local circumstances, being as low, in the case of Sheffield, as 7d. per yard, and as high in London as 2s. 3d. From information obtained some time since I found that the general price of this kind of pavements was about 1s. per yard, exclusive of the cost of preparing the foundation. The price I have given for Ipswich paths includes the foundations. Tar pavements are generally adopted as an improvement on gravel paths, and are not supposed to be regarded as a material to be taken in comparison with asphalte, although I think they bear favorable comparison to many of the more costly pavements, and are, in my opinion, much to be preferred to the common asphaltes prepared from pitch, to say nothing of the difference of cost, and which expands and contracts with variations of temperature. I have tried other materials for making cheap pavements for footways, such as bricks, earthenware tiles, and Portland cement concrete, but the cost, which is about 4s. 6d. per superficial yard, precludes their use for suburban paths, and their durability is not sufficient to allow them to be put in the place of York flagging for main streets. A path made from shingle, and repaired in the way I have described, would last, with the ordinary traffic of a provincial town, ten years. Paths laid under my directions as long since as this are still in fair condition. It is, however, difficult to say what the life of pavement would be without very careful observations extending over a considerable period, as the duration of any paved footway is simply determinable by the amount of traffic. Having regard to the economy of first construction, reduction of dust and scavenging, and the cleanliness of the path after rain, it appears to the writer that there is no better material for suburban footways than tar pavement. It may be objected that the dull appearance, and the difficulty of repairing them so as to bring the repaired part even with the old, and the disturbance of the paths caused by laying on gas and water, is against their adoption. The first objection can be avoided by using a good covering of Derbyshire spar, and the second applies more or less to any pavement, with the exception of York flagging. When I commenced to lay these paths ten years ago they were rather scarce, and had only been laid to a limited extent in a few towns, but during the past five years they have been very largely extended, and will in future occupy a permanent position amongst other paving materials for constructing footways in towns; this shows the suitability of the material for such footways as I have referred to in this paper. There are now about 15 miles of these paths in Ipswich, taking the place of paths which would, if they had not been superseded with this material, have still been muddy in the winter, and so rough on the surface in summer as to make them always more or less unpleasant to walk upon, to say nothing of the indirect discomfort to the inhabitants by reason of additional dirt in winter and dust in summer. The cost of paving this length of footways with other material would have been so considerable as to have prevented the possibility of doing it, and I look upon it as a great boon to the inhabitants of any town to get such good pavements for suburban paths at such a small cost.—*Building News.*

FIRE-PROOF FLOORING.

MR. W. H. COZENS-HARDY writes to the London *Times* from Letheringsett Hall, Norfolk:—"Having had a considerable fire on my premises some years ago, I was much interested in the account you published some weeks back of the fire-proof flooring designed by Messrs. Evans and Swain. I have a large malthouse, 40 ft. by 18 ft., which was built about the year 1824, over which is a chamber of the same size for storing barley and malt. The floor was made without any joists, and having resisted the ravages of a large fire on the 1st of April, 1827, it may interest your agricultural readers to learn how it was constructed. The building is 40 ft. wide, and strong beams, 6 in. by 15 in., were placed on the brick walls 7 ft. apart, each beam being supported by two wrought iron columns. Upon these beams 3 in. deals, 'grooved and tongued,' were fastened without any joists. The fire originated in this chamber from the spontaneous ignition of high dried malt, and in less than an hour the whole roof fell upon this floor. Some time elapsed before a fire engine could be obtained. At length the fire was got under, but continued to burn for some twenty-four hours afterwards. To my astonishment none of the beams were destroyed, and the floor was scarcely at all injured—only about a dozen small holes having been burnt through—and the floor exists at the present time as strong as it was fifty years ago. I may observe that this floor, though somewhat novel in its construction, was simply made for strength, and without any idea of its being less liable to be destroyed by fire than ordinary floors. I am quite certain that the safety of this floor arose entirely from the 3 in. deals being 'grooved and tongued,' thus preventing the air from getting between the joists and feeding the flames. If a floor on this principle were made with a double thickness of 3 in. deals tongued with hoop iron, one above the beams and the other under, with concrete between, and with a ceiling of thick plaster, as suggested by Messrs. Evans and Swain I have no doubt it would resist the action of fire much longer than any so-called fire-proof buildings, and the cost would be very trifling. I shall be happy to show my malthouse floor to any one who may wish to see it." The experience of Mr. Cozens-Hardy lends practical support to the system of construction advocated by Messrs. Evans and Swain, experiments by whom have shown conclusively the correctness of their views.

LOCOMOTIVE CROSSHEADS.

WE give engravings of which Figs. 1 to 3 show the standard type of locomotive crosshead adopted by Herr Borsig, of Berlin, while Figs. 4 to 6 illustrate a pattern of crosshead which has been substituted for Herr Borsig's on a number of engines on the Griazi-Tzaritzin Railway, Russia, by Mr. Thomas Urquhart, the locomotive superintendent of the line. Herr Borsig's crossheads are produced by the process of hydraulic forging, and we have on former occasions spoken of the neatness of their design. On the Griazi-Tzaritzin Railway, however, it appears that during six years' service as many as thirty of these crossheads gave way as shown by the line AA in Fig. 2, while a few of them also gave way as shown by the line BB in Fig. 1, and these failures led Mr. Urquhart to design the type of crosshead shown by Figs. 4 to 6, and to substitute them for Herr Borsig's original pattern.



CROSSHEADS FOR LOCOMOTIVE ENGINES.

Mr. Urquhart's crossheads are forged from scrap iron, the pieces between the cheeks being slotted out and the crossheads being casehardened. The slides are of cast iron lined with white metal, and they are found to wear well, running about 14,000 miles without requiring relining. The slides are adjusted by the interposal of thin liners between them and the crosshead, while the relining with white metal can be done at any depôt, the slides being simply run up in their places. The crosshead pin, as shown in Fig. 6, is tapered on each side of the crosshead and is held in place by a nut as shown. Altogether Mr. Urquhart's crosshead is of very neat and simple design, and it has been found to give no trouble.—*Engineering.*

PROGRESS OF AMERICAN RAILWAYS.

THE statistics of 1876 show a considerable falling off in gross earnings, although, by strict economy, the net earnings are made to show a little larger than last year. The number of miles operated in this country last year were 73,508, against 71,759 in 1875. The gross earnings amounted to $497,200,000, against $503,100,000 in the previous year, while the net earnings were $186,400,000, against $185,500,000 in 1875. The

increase in net earnings, in the face of the large falling off in gross earnings, is attributed to the spirit of economy which has characterized railway management during the past year.

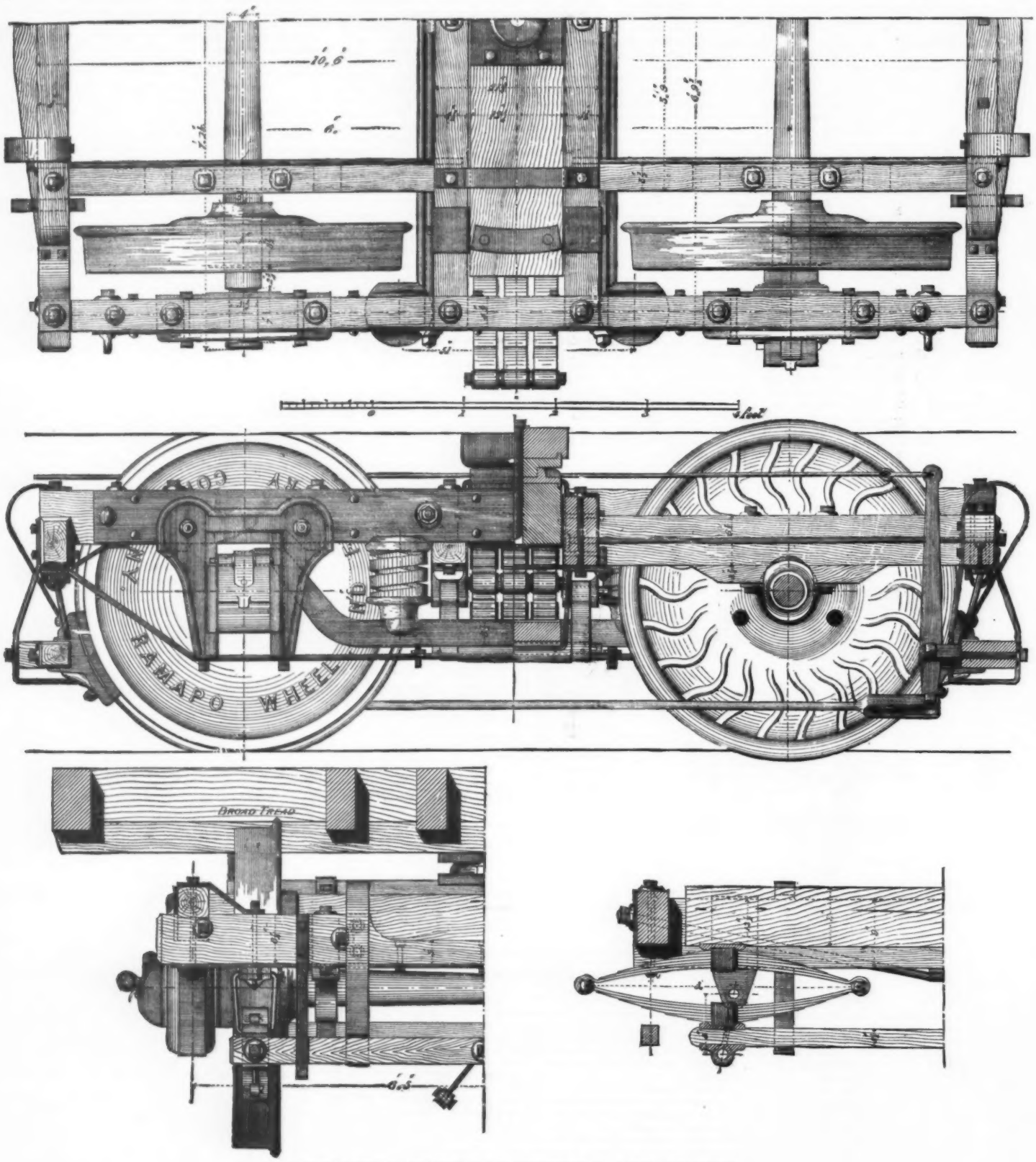
FORTY-TWO INCH CAR-WHEEL TRUCK.

THERE has been a great deal of discussion recently about the diameter of car-wheels, and the idea that the wheels now generally used are smaller than they should be has gained ground very rapidly among many railroad men. For these reasons our readers will be interested with the engravings of a truck designed for 42 in. wheels and published herewith. The arguments used in favor of 42 in. as against 33 in. wheels are, first, that the former make fewer revolutions in running a given distance, and therefore cause less axle friction. Second, a large wheel will surmount an obstacle or inequality on the track with greater ease than a small one. Not only will less power be required to roll the large wheel over an obstacle, but the jolt produced thereby will be less violent and the motion of the vehicle will consequently be easier than if mounted on small wheels. Third, large wheels have a greater effective bearing area on the rails than smaller ones, and consequently the wear both to the wheels and to the rails will be less with the former than with the latter.

It is true that a stronger axle is required with a large wheel than with a small one, but the strain due to the increased diameter of wheel is exerted on the axle chiefly at the inside of the hub of the wheel, and there is no reason for believing that any increase in the diameter of the journals is needed if the diameter of the wheels is increased. Thus with a 33 in. wheel and a master car-builders' standard axle, the proportions of the diameter of the wheel to the axle is as 5 to 44; with a 42 in. wheel it is as 5 to 56. The motion of the rubbing surfaces is therefore less in the one case than in the other, and at the same time the journal will make fewer revolutions with the large wheel than with the smaller ones in running a given distance.

The master car-builders' standard axle is, it is believed, large enough for 42 in. wheels, and would give as great security as the present axles in general use now give with 33 in. wheels.

The Ramapo Wheel and Foundry Company has given special attention to the manufacture of these large wheels, and the truck which we illustrate was designed for that company.



FORTY-TWO INCH CAR-WHEELS AND TRUCK.

It would be a serious obstacle to the introduction of 42 in. wheels if it were necessary to use the car bodies and the draw-heads in order to raise them; and the chief effort of the designer of the truck illustrated has been to avoid such necessity. To do this he has lowered the bolsters, and cut the wheel piece, as shown by the dotted lines. The wheel piece is then strengthened by attaching an iron plate $\frac{5}{16}$ or $\frac{3}{8}$ in. by 7 in., as shown by the engraving. In this way the full strength of the truck is preserved, while the car-body and draw-head are of the same height as at present with 33 in. wheels.

The Ramapo Company first supplied these wheels to the Pullman Palace Car Company about a year ago, and now they are in use on the Grand Trunk, the Lake Shore and Michigan Southern, the Flint and Pere Marquette, the Atchison, Topeka and Santa Fé, the Boston and Providence and the Boston and Albany railroads, while they have been ordered by the Maine Central, and other lines are preparing to introduce them. Thus far the results are reported to be entirely satisfactory.—*Railroad Gazette.*

THE GREAT TUNNEL.

UNDOUBTEDLY the greatest mining work in progress in the the West is the Sutro Tunnel. Begun under adverse circumstances, and carried on under the opposition of most of the rich and powerful companies of the Comstock, as it now approaches its completion, its importance to the Washoe mines becomes more apparent, and there is much speculation in regard to the influence it will exert and the part it will fill in the future of the great vein. Owing to the tremendous depression in Comstock shares, there are now many who think that the palmy days of that mine are over; that a depth has been reached at which the expenses of hoisting and pumping are so great as to offset the possible profits of all but the hughest and most extensive bonanzas, and that the great heat existing in the lower levels will in a few years more compel the abandonment of the mine, unless new means of ventilation are secured Under these discouraging statements the Sutro Tunnel assumes an importance second to no enterprise in the West, for the cessation of work at Washoe would result in the curtailment of American bullion production of nearly $20,000,000 annually. It is but recently that so much interest has been felt in this enterprise. For many years few thought the work would be completed, but now all doubts on that score are removed. The header of

the tunnel is advancing towards the Comstock at the rate of ten feet per day, and in a few months will enter the formation in which lies the great lode. Some facts regarding it will, therefore, not be amiss.

Its mouth is in the valley of the Carson River, a stream which washes the eastern base of the Washoe Range, in which the Comstock lies. It has been driven a total distance of 17,000 feet up to date, and is progressing at the rate of 300 feet per month. Not more than 2,800 feet now intervenes between the breast and the nearest mine on the Comstock, the Savage, so that, if the present rate of progression were maintained, about ten months more will suffice to complete the connection. The lode will be cut at a depth of about 1,800 feet perpendicularly below the surface, and very nearly the center, measuring by the extent of the surface workings. It is then proposed, either by the Sutro Company or by a combination of owners along the vein, to run a drift north and south through each claim until the ends of the vein laterally are reached. This will connect every mine on the vein with the tunnel; will drain the entire workings; and, should these lateral drifts be put under one management and made a common highway, will afford the means of working the entire vein through one opening.

It is now about eight years since work was first begun at the town of Sutro, on the Carson River. The expense of prosecuting the work has averaged about $1,000 per day, and when the Comstock is reached the total cost will have amounted to about $3,000,000. The tunnel is double-tracked, as straight as an arrow in its course, with a rise just sufficient for drainage. Three air shafts have been sunk along its course.

At the mouth of the tunnel the Sutro Company have laid out a town, have secured magnificent water-powers, and expect to realize largely on that part of their investment by the removal of most of the mining and milling operations on the vein from Virginia City to the Carson.

The fear has been expressed of late that, when the soft and yielding formation in which the lode lies is reached, great difficulties will be found in keeping open the tunnel; that the strongest of timbering, and even masonry, will be unable to withstand the enormous pressure. The trouble Mr. Sutro confidently expects to overcome. Already several ore channels have been crossed in penetrating so far into Washoe Range, and, though some trouble was encountered, it was overcome completely.

There are now many rumors afloat pointing to the consolidation of interests between the Tunnel Company and some of the more prominent mines. The indomitable will and energy of Mr. Sutro have overcome, one by one, each and every obstacle placed in his way by those who opposed his enterprise; there is hardly a chance that, in the hour of his success he will submit to anything short of a controlling interest in his work. When the vein is at last reached, and the immense benefits that it certainly will bring to all the mines shown, it is very doubtful if the belligerent owners who have all along threatened to control the rights of the tunnel will attempt to injure its usefulness or refuse to benefit by it.—*Engineering and Mining Journal.*

THE UCHATIUS GUN.

Of all the Powers, it is curiously enough steady-going Austria which has taken the boldest and most independent course in the matter of artillery. It was but at the end of 1875 that the Austrian War Office decided to adopt the Uchatius cannon for field artillery, and yet at this moment every artillery regiment of the vast Austro-Hungarian army is armed with the new weapon. Within eighteen months no less than 2,000 of these cannon have been cast and finished, and now the Vienna arsenal is engaged in the manufacture of heavy guns of the same character. Never was a more energetic step taken. A new cannon of some sort was held to be absolutely necessary to uphold the prestige of the army, and a commission having been intrusted with the selection of an arm, pronounced without delay in favor of the scheme brought forward by General von Uchatius. In October, 1874, the first round was fired from an Uchatius gun, and twelve months afterwards a sweeping reform, which was to introduce an entirely new artillery throughout the Austrian service, was decided upon. Government sanctioned an expenditure of £1,800,000, to be spent in two years, and General von Uchatius was directed to give all the assistance in his power toward the fulfillment of the design. The Uchatius gun is made of so-called steel-bronze. Chilled bronze would be a better name, since Uchatius casts his metal in a chilled, or metal mould, in the same manner, pretty well, as Sir William Palliser produces his famous chilled projectiles. Bronze, as everybody knows, has been a favorite metal with gun-founders from the earliest days, and in the East, especially magnificent castings of this nature have been produced. About 90 per cent. of copper and 10 of tin is the mixture commonly employed in making ordinary bronze, but 8 per cent. of tin is the proportion preferred by Uchatius. The difficulty in casting bronze, as those who have any experience know full well, is that of securing homogeneity, soft particles of tin becoming isolated in the mass, and giving rise to the defect known as "tin-pitting." Whether we have lost the secret of bronze-casting, or whether in former times they were more skillful at the work, certain it is that founders of the present day are unable to secure so uniform an alloy as formerly. This was very apparent when some eight or ten years ago our own Government adopted, for a brief time, bronze artillery. The addition of a small percentage of phosphorus did not mend matters, and the highest authorities on the subject were at a loss to suggest an effective remedy. Our bronze guns, too, had another defect which could not be overcome. After firing the bore became affected, and the weapon, as it was termed, "drooped at the muzzle." These were the two defects indeed that led mainly to the abandonment of the bronze gun in this country, and they are, too, the difficulties which General von Uchatius appears to have overcome. He has got rid of "tin-pitting," and his guns do not 'droop at the muzzle." Uchatius found that by subjecting the alloy in a liquid form to considerable pressure, he was enabled to secure a perfectly homogeneous mass, a result which was also furnished, he discovered, when he had gone a step farther, if the molten metal was rapidly cooled. Steel bronze is apparently made much in the same way as the toughened glass, of which we have heard so much lately. After casting in a mould, the alloy is thrust into a reservoir of oil, heated to a high temperature, so that the metal suddenly cools, but only down to a certain point. Then the casting is withdrawn and allowed to get cold more gradually. A regular and crystalline structure is in this way produced, which has none of the defects of ordinary bronze. It is a moot point whether phosphorus enters into the composition at all. Chemists tell us they can find no trace of it, but this is no absolute proof that a small percentage of the element was not originally contained in the alloy, being burnt out after it had done its work of harmonizing the two metals. The inventor is rather reticent on the point, but in any case it is very certain tha the produces a uniform and homogeneous alloy of a hard crystalline nature. One other expedient Uchatius has recourse to in making his cannon. When he has cast his gun and chilled it he proceeds to dilate the bore. Wedges of steel, shaped in the form of cones, are forced in the tube of the gun one after another, until the calibre of the weapon has been increased by something like 7 or 8 per cent. This expansion or dilation of the tube has not only the effect of hardening or steeling the core, but also of rendering the gun more elastic and capable of resisting more effectually the strain put upon it at the moment of firing. The gun, after this process, is in a state of elastic tension, and it is said that there is a pressure from without, inwards, equal to that which was exerted to dilate the gun in the first instance; and that this is actually the case can scarcely be doubted, since it is a fact that a section of the gun, before being quite severed, will tear itself loose with considerable violence, and will be found on separation to have partially returned to its former calibre So far as practicable trials have been conducted with the weapon, the Austrian Government have every reason to be satisfied with the Uchatius gun, which compares favorably with the Krupp steel cannon in the matter of accuracy and durability; while as regards its cost, it is far cheaper than any other rifled ordnance. A steel field-piece costs upwards of £100, even when not protected with rings, while the iron steel weapon manufactured in this country costs about £70 sterling; the steel bronze cannon of General von Uchatius, on the other hand, are made for £35 apiece. In construction, the Austrian gun is so similar to that of Herr Krupp, of Essen, that the latter claimed compensation for an infringement of his patent when the manufacture of the Uchatius gun was first commenced. The Essen works, our readers may know, supply not only Germany with steel breech-loaders, but have provided the present belligerents with all their modern artillery. Russia has still many brass cannon on hand, and Turkey a goodly number of Armstrongs, but both Powers mainly depend upon their steel Krupps. These stood the German army in such good stead during the last war that their reputation is firmly established. They are of crucible steel, and the breech, instead of being upon a hinge, or in the form of a block, moves round a D shaped socket, the escape of gas being further prevented by rings of phosphor-copper.—*Nature.*

IMPROVEMENT IN THE MANUFACTURE OF BARRELS.

By RALPH M. MUNROE, Edgewater, N. Y.

LET us suppose the two cylinders of wood, D and E, one within the other, to have been placed in position while the forming and compressing parts of the machine O and P were further apart, so that the ends of the barrel-cylinder would rest in a part of the compressing die which has a greater diameter than the end of the barrel. As the compressors approach each other, the sides are contracted and the barrel shape given to the cylinder. In order that the

Fig. 1.

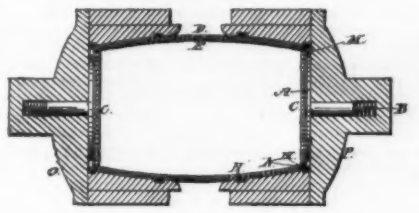
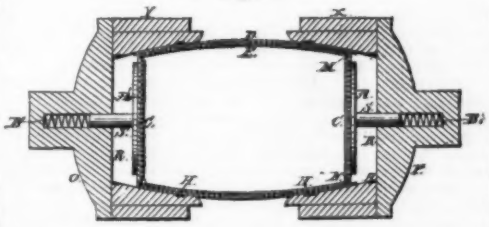


Fig. 2.



head shall be in such a position that the contracting ends of the barrel shall meet and catch it, but yet shall be able to continue their movement into the compressors and close firmly upon it, I place in the compressing or forming part of this machine two head-carriers, A and A'. Upon these head-carriers are placed the heads C, attached thereto by glue, or some other way.

These head-carriers are not firmly fastened to the moving compressors, but are carried by shafts S and S', controlled by springs B and B'. This movable head-holder performs three functions. In the first place, it holds the head in such a position that it is grasped by the incoming barrel-sides. Then, after the head has been seized by the sides, the head-holder yields to the forward motion of the barrel or of the machines, and thus it forces the inner barrel to assume a central position with reference to the outer barrel. I limit my mechanical invention to the improvement in head-holders just described.

Now, let us suppose the machine to be operated and the compressors to approach; the sides of the barrel, as they are compressed in the die, move one over the other, in order to assume their compressed condition, as shown in Fig. 1. In order that they may accomplish this readily, and may easily take the required shape, I heat or steam them thoroughly, and place between them some oil or lubricating substance, or glue, which has the same effect—namely, to allow the pieces of wood to move freely over the other.

Now the position of the head C, held upon the holder A, and the sides of the barrel, is such that, as the sides or ends of the barrel approach one another, the inner barrel E will pass inside the countersunk outer head M, so that the two corners will catch or bear against one another, as shown at M. As the compressors approach one another the head can pass no further into the barrel, being held at the corners M and N. The action of the spring now begins, and the head being held firmly in position against the ends of the inner keg, or the barrel E, the machine continues to compress the sides until they embrace and hold firmly in their dovetailed recess the heads of the barrel.

Hoops H H H, etc., are placed in recesses in the compressors, as shown in the drawings. When the compressors have completed their movement, the head-carriers A A' bring up against the sides R of the compressors at both ends. The result of this is, that the inner barrel is now moved one way or the other, so as to register and coincide with the outer barrel, being pressed in equally from both ends by the carriers A and A', which are of equal width. At the same time the heads, being firmly in, are embraced by the contraction of the barrel, so that they can neither be moved in nor out. One half, usually the upper half, of both compressors is made movable, as at *x* and *y*, so that on completion of the barrel this half, being thrown upward on its hinge, leaves the hoops behind. The barrel is then removed from the machine, having the hoops in position. In other words, the barrel is taken from this machine complete in all respects.

The amount of lubricating material used in forming these kegs is accurately determined by experiment, so as to be sufficient to fill all interstices and cracks in the barrel, and to allow the passage, one over the other, of the moving parts. It is evidently very important that the countersunk heads should be put in position and firmly fastened, by one movement of the compressor, by apparatus outside of the barrel itself.

In the manufacture of barrels which are to contain petroleum, I use a glue which is insoluble in it, and thus make a tight package.

ON THE PRIMING OF STEAM BOILERS.

By Mr. WILLIAM MAJOR, Engineer, Danish Royal Navy.*

SOME time since the author read a long article in an engineering publication on the boiler fatalities on board her Majesty's transport ship Serapis, on her voyage out to India with the Prince of Wales. The substance of that article was that the engineering profession was still ignorant of the real cause of what is technically called "priming." It is certainly humiliating for the profession to be obliged to admit that one hundred years after the introduction of the steam engine they are still unable to subdue an evil so generally experienced as the priming of steam boilers; yet such is the case, as proved by the Serapis. The first question to be solved is: What is the cause of priming in a steam boiler? and until this question is satisfactorily answered engineers will still go on devising mechanical contrivances for obviating it, and their efforts will end in as many signal failures as hitherto. If we ask a practical engineer what the cause of priming is, we generally have dirty water assigned as a reason, and a specific is given for its prevention; or, what is more usual, since the more general introduction of high-pressure steam boilers, some remarks not very complimentary to the constructor of the boilers of which he may have charge and the priming of which he is unable to master. If we ask the same question of a scientific man—a professor of chemistry for example—he will answer that priming is ebullition caused by the action of heat on the body of water contained in the boiler, but he is not quite certain as to whether this so-called ebullition is a chemical or a mechanical action. With this meagre information the profession has had to content itself, enduring at the same time all the evils attendant thereon.

In the case of the Serapis we have a ship engined with a power sufficient to propel her through the water with a speed of 13 knots an hour, but that engine power was so paralyzed through the priming of the boilers that her speed was reduced to 9 knots. The case of the Serapis is by no means exceptional, the same evil obtains in a greater or less degree on board every steamship afloat, and the introduction of high-pressure steam together with the surface condenser has very considerably increased the evil. Indeed, break-downs from large bodies of water passing with the steam from the boilers to the cylinders of the engine are daily occurrences, and more valuable steam engines are destroyed from this cause than from all other causes put together. The author need not enlarge further on the subject of priming and its consequences, but will observe that he feels assured of having discovered a better theory for the cause of priming in steam boilers than is yet generally known. He has also found a practical means of preventing the evil, and that too without putting shipowners to any expense, but on the contrary, since to stop priming is to save fuel. The author does not propose any costly or complicated machinery for the purpose of preventing priming, not even a wooden deck placed in the boiler, as it was stated was adopted in the Serapis' boilers. As before stated, the cause of priming is said to be ebullition in the body of water contained in the boiler caused by the heat acting on the water. The author is bold enough to alter the word "ebullition" into the more intelligible word "friction," and he ventures to assert that priming in steam boilers is—as nature's simple law ought long ago to have taught us—caused by friction on the outer surfaces of the steam globules as they pass up through the overlaying body of water into the steam chest, the amount of such friction being always in due ratio to the velocity at which they pass through the body of water, and also depending upon the state of the water as regards its purity. In other words, the friction is least when the water is pure—distilled—while it is the greatest when the water is charged with all the organic and inorganic matter it can hold in solution. The author is only now, after four years' practical experience on a large scale, publicly making the above assertion, and with the full conviction of its correctness.

Having satisfied himself as to the feasibility of the friction theory, it occurred to him that we had mistaken the real effects or action of the old-fashioned system of injecting melted tallow into boilers for stopping their priming. The reason generally given why tallow or other fatty matter stops priming is because it spreads itself over the surface of the water and quiets it. The author, however, does not believe this is the case, since whenever there is a pressure of steam in a boiler, any fatty matter injected into it immediately diffuses itself throughout the whole contents of the boiler, both water and steam. That this is the case can be proved by simply drawing a glass of water from any part or height of a boiler charged with tallow or by condensing a portion of the steam. Both the taste and smell of tallow will be found in both cases. The author believes that fatty matter stops priming by lubricating the globules of steam as they pass through the overlaying body of water, reducing the friction on their surfaces, and, as a natural consequence, causing them to carry less water with them into the steam chest. So long as we continue to supply a boiler with a sufficient quan-

* Read before Society of Engineers.

ON THE PRIMING OF STEAM BOILERS.

tity of fatty matter, priming will not take place. But it so happens that we cannot use the quantity of tallow, nor indeed of any other ordinary fatty matter necessary for the purpose, without producing other evils which it is difficult, or even impossible, to contend with, at the same time the expense of their use would be greater than most shipowners would like to bear. Tallow contains so much insoluble matter, that if used in the required quantity it would soon choke the boiler up, while both animal and vegetable oils contain so much gummy or resinous matter that they would soon cause evil effects on the interior of boilers if large quantities were used. Of all the patent compositions the author has seen or heard of, he has found none that will answer the purpose—at any rate neither for marine nor for locomotive purposes, simply because the chief cause of priming—impurities in the water—is never absent. Therefore what is required is a constant supply of the proper lubricating matter to prevent the baneful action of these impurities on the globules of steam as they are generated. For marine boilers in particular, too great a stress cannot possibly be laid on the simple fact that the cause of priming is never absent so long as the boiler is in use, or supplying the engine with steam, because the water pumped into the boilers always contains either organic or inorganic matter. And this is the case whether the engines are or are not fitted with surface condensers. If the engine is fitted with surface condensers, priming will in most cases be more severe than with the injection condenser, because the action of heat on the metal plates of the boiler is more intense where there is little or no lime on the plates, as with a boiler fed from a surface condenser, than from an injection condenser, where the water is being constantly changed, leaving all its organic and inorganic contents, with the exception of common salt, in the boiler. Consequently a constant supply of fatty matter is absolutely necessary to counteract the friction caused by these impurities.

The author has tried all the oils in common use, together with most of the patent compositions, for the purpose of preventing priming. He has always succeeded in the object sought, but has found them all impracticable when used in large quantities, or constantly supplied to a boiler. The only exception to this rule has been the application of petroleum. The purest rectified petroleum has not only prevented all priming, but has prevented corrosion and removed incrustations arising both from organic and inorganic impurities, and from oxidation of metals as regards the interior of the boilers, as well as of the engines themselves. It would, indeed, appear that by using sufficient petroleum to lubricate the steam globules as they are generated, the preservation of the steam boiler and engine is insured so far as their interiors are concerned. The author has not found that petroleum, pumped into the boilers with the feed-water, has had any injurious effect on india-rubber valves in or about the air pumps, though he has used it in large quantities for several months in succession. In the feed pumps, however, where petroleum, nearly in its pure state, comes in direct contact with the valves, india-rubber cannot be used for them. The advantages attained by the use of sufficient petroleum to prevent the priming of steam boilers have been found by the author to be :—

(1.) The prevention of priming, or, in other words, preventing large bodies of water from passing over with the volume of steam from the boiler to the engine.

(2.) The prevention of the injurious effects produced by water passing with the steam into the cylinders of the engine.

(3.) A great reduction in the quantity of feed-water necessary to produce the required volume of steam, or, in other words, an augmented boiler steaming power in proportion to the smaller quantity of water required to produce the steam required, or a saving of fuel proportionate to the smaller quantity of water necessary for producing a given volume of steam, together with the reduced power required for lifting water for condensing dry steam as against that necessary for the condensation of saturated steam. To these must be added the saving of the power absorbed in overcoming the resistance of water in the ends of the cylinders when working with saturated steam.

(4.) Augmented boiler steam power when working with injection condenser, by the total absence of incrustation or corrosion.

(5.) Prevention of rust, corrosion on the interior of the engine, together with the advantage of keeping the interiors of surface condensers perfectly clean without any other help.

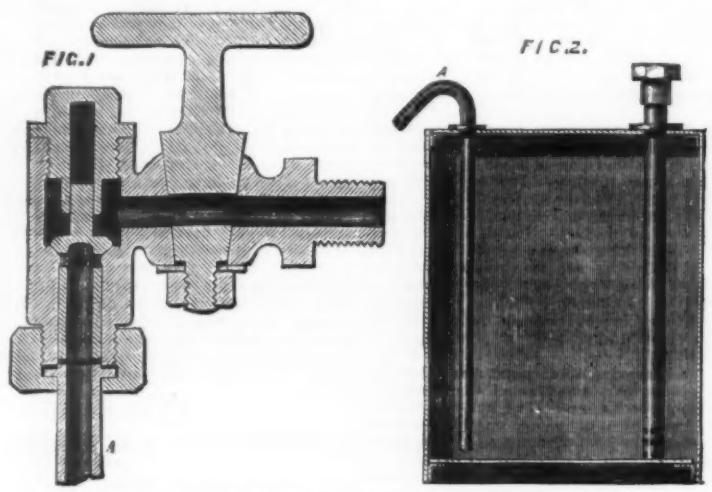
(6.) Its instantaneous action on any disturbance in the water in the boilers, which is one of its greatest advantages.

(6.) The increased durability of both boiler and engines.

The advantage of using petroleum in an engine-room—for there is one disadvantage—is that petroleum is a combustible article which requires care in use. It ignites at a lower temperature than common oils, but with ordinary care, and keeping it out of contact with cotton or woolen stuffs the danger of its use in engine rooms is reduced to the same extent as that of its use in dwellings. It is, indeed, reduced to a far greater extent when it is stored in a fixed iron tank with but one opening on top for filling and connecting a suction pipe to the feed pump of the engine. The danger is then reduced to the bringing of it to the tank. Petroleum will not ignite or burn in a closed vessel; a bar of red hot iron inserted into a closed cistern full of petroleum will not ignite it, because there is not sufficient atmospheric air for combustion. The author knows of no other danger or disadvantage in its use, and when this one disadvantage is put against the many advantages, and when it is considered that its use prevents marine engines from becoming paralyzed, as but too often is the case at most critical moments, no practical engineer will, it is thought, differ from the author in the opinion that it will be wise to promote its general use.

In applying petroleum to boilers the author has constructed a combined valve and cock, as shown at Fig. 1 in the drawing. This contrivance is screwed into the valve box of the feed pump between the suction and delivery valves, the safety cistern shown at Fig. 2, containing the petroleum, being placed in a convenient part of the engine-room. As the connection pipe A is inserted through the top of the cistern, while no other cocks or connections on cisterns are allowed, no danger can ever arise from inadvertence on the part of the men in the engine-room. This valve and cock is all that is required in addition to what is generally found in well-constructed steam engines—namely, a cock on the suction pipe, or a screw on the top of the suction valve of the feed pump, one of these being required for regulating the flow of water to the pump necessary for generating the volume of steam required, and the prevention of waste of petroleum, since any overplus of water the pump takes, and which does not pass into the boiler, is returned through the safety valve on the pump. The author has in practice regulated the water flow to the pump, so as to approach as nearly as possible the consumption in the boilers, leaving the feed cocks full open. This has given two advantages: First, no petroleum was wasted; and, secondly, it has directly shown when the steam was taking an undue quantity of water with it. That it is in the boiler itself that priming must be prevented appears evident, and it is equally evident to the author that all the mechanical devices for the purpose of preventing it have, for the want of the proper knowledge of the cause of priming, signally failed. Some of these devices—the superheater, for example, which is still in general use—are very complicated, and consequently very expensive.

The valve and cock applied to insure instantaneous action must have the necessary dimensions in proportion to heating surface in boilers it is intended to supply with petroleum. On starting the engines, or when forcing the fires, priming is generally most violent, and at such times the engineer's immediate attention is necessary, and he will act wisely in giving his boilers a little petroleum previous to forcing the fires. On a voyage from Copenhagen to St. Petersburg and back, with his Danish Majesty's steam yacht Slesvig, last



summer, nearly 144 hours' steaming, the author consumed nearly forty gallons of petroleum, and this gave a gain of twenty-five tons of coal, compared with what the same boilers and engines had previously consumed on the same journey in about an equal number of hours, namely, 150 instead of 175 tons of coal. The ship, however, was drawing 2 in. more water last year than formerly, which increased her immersed midship section from 219 to 224·7 square feet, or 4¾ square feet nearly. There was, besides, the disadvantage of being in company with a screw frigate, whose sailing powers far exceed in speed the Slesvig's steaming powers, so that the author was constantly either forcing or easing the engines to keep in position with the frigate, which caused a considerable waste of fuel. The Slesvig has a pair of Robert Napier's old fashioned side-lever engines with open condensers, and of 240 nominal horse power, but which the author is now enabled to work up to 620 indicated horse-power. With the same draught of water as now, about 9 ft. 4 in., her speed formerly never exceeded ten and a quarter knots, and this speed was with difficulty maintained for any length of time, for the want of sufficient steam. Since the application of petroleum to the boilers, however, the speed has been increased to eleven knots, and this without any increase in the consumption of coal. The steaming power of the boilers has been increased so much that there is now more steam than the engines consume, while the engines themselves are working with less noise than formerly.

The author succeeded last summer in removing all corrosion and incrustation from the interior of the Slesvig's boilers, and they are now as clean as when they left the boiler maker's hands ten years ago. Petroleum dissolves both the lime incrustations and prevents rust corrosions when under steam pressure, while all the dissolved muddy matter can be blown out from the bottom of the boiler with the ordinary blow-off cock; the boiler requiring no other cleaning out, and consequently there are no stoppages for this purpose. It may be interesting if, before concluding his paper, the author places on record a circumstance which came under his observation last year respecting marine boilers in connection with surface condensers and the use of mineral oils.

When the surface condenser was introduced in connection with marine engines one of the advantages expected to be derived from it was the freeing boilers from incrustation, and thus increasing the evaporating powers of the boilers; the danger of collapse arising from overheated fire-box plates was to be removed. The surface condenser was intended to return to the boiler the water taken therefrom in the form of steam, and as this water could contain no organic or inorganic or earthy particles, it was very natural to suppose that no incrustation could be formed in boilers supplied with them. But one of the first discoveries made after the introduction of the surface condenser was that the boilers supplied from it corroded them to an alarming extent, so that in many instances such boilers were entirely destroyed after only two years' service. This circumstance prevented their coming into general use until about twelve or fifteen years ago, when it was discovered that the corrosive action was caused by metallic particles taken from the interior of the engine by the steam on its passage through it, and carried into the boiler, where they produced a galvanic action which oxidized the plates of the boiler. About the same time it was also discovered that sea water contained the best non-conducting agent for preventing a galvanic action in the interior of the boilers, namely, its organic and inorganic contents. In fact, the same matters which had hitherto caused incrustations were now found necessary, in smaller quantities, to protect the boilers against oxidation. This protection is afforded by changing the water in the boiler, occasionally with water direct from the sea, which leaves a coating of its organic and inorganic contents on the interior surfaces of the boiler, and thereby insures safety from galvanic action, and permits the general use of the surface condenser with marine engines. We have, however, for several years past heard of the collapsing of fire-box plates where they have been in connection with surface condensers, and the opinion invariably given as the cause of these accidents has been that there was either a want of strength in the construction to assist the steam pressure, or that there had been carelessness on the part of the attendants in not supplying the boiler with sufficient water. This, however, is a great mistake, as there are other causes equally as active in causing fire-box plates to collapse as those just named. One special cause came under the author's observation. About midsummer last year the screw steamship Conatio, of Flensborg, on her way from Cronstadt to an English port, was towed into Copenhagen harbor in a disabled state. The four fire-boxes of the boiler had collapsed. They appeared to have all given way at about the same time. The firemen, on opening the fire-doors, saw the crowns of the fire boxes sinking, and the engineer immediately opened the smoke-box doors, and took other precautions for reducing the steam pressure, and thereby in all probability saved his own life and the lives of the rest of the engine-room crew. Upon reaching the port the boilers were examined. There was plenty of water in them, and everything else appeared to be in perfect order; yet, on emptying the boiler, the injured crown plates of all four fire-boxes afforded clear evidence of overheating—in fact, they had been red hot, and this notwithstanding that there had been plenty of water in the boiler, and that there was but a trifling deposit. The only reasonable conjecture as to the cause of the accident was that on the collapsed plates was found a thin layer of ordinary boiler incrustation, not more than a twelfth of an inch thick, mixed with a dark substance, which proved on examination to be the insoluble residue of a mineral oil, which had been used for the purpose of lubricating the interior of the engines. The lubricator used was fixed on the side jacket of the high-pressure cylinder, and from thence the oil passed through the surface condenser to the boiler. This insoluble matter then mixed with the slight incrustation, and which, thin as it was, had been sufficient to make a perfectly impervious coating, which had prevented the contact of the water with the iron plates. Hence the overheating and collapsing of the crowns of the fire-boxes.

In the month of September last the author was requested by the Danish Board of Trade to survey and report upon the condition of a boiler on board a merchant steamship, the Bergen Huns, of Copenhagen. This vessel came into port at Copenhagen with a boiler which had been disabled on the voyage from Norway to Stettin. Here was a similar case to that of the Conatio, only perhaps a little more decisive as regards the cause of the accident. The Bergen Huns is fitted with compound engines supplied with steam from a cylindrical boiler having two cylindrical fire-boxes in it, one of which collapsed. The fire-box collapsed 8 in. in towards its center over a length of 4 ft. 6 in. from the back end, not, as might be supposed, along a line drawn perpendicularly through its center, but at an angle of 45 deg. with it towards the side of the ship. In this case the engineer, seeing there was no want of water in the boiler, ordered the fire to be drawn out of the collapsed fire-box and proceeded with the other fire on his voyage, and came in to Copenhagen some twenty hours afterwards. Such a piece of dangerous stupidity succeeded in his case, but has probably failed in too many others under such circumstances.

On examining the interior of this boiler the author found that half of it—namely, that side on which the feed-cock was fixed—was coated with a substance resembling black varnish or coal tar, having a thickness of about three-sixteenths of an inch and being perfectly impervious to water. This deposit had the appearance of having been laid on with a brush, so equally was it spread, particularly over the fire-box. It was under this coating of impervious matter the fire-box plate had collapsed, while the other fire-box remained uninjured, notwithstanding that it had a coat of ordinary boiler incrustation ¼ in. thick. The incrustation on this side retained its ordinary gray color. On inquiring of the engineer from whence this black substance came, he stated that it was produced from the oil used to lubricate the slide valves with. He observed that he was obliged to use a great deal of the oil to keep the valves from making a noise and cutting their faces. The oil used for this purpose was a half crude mineral oil, which still retained so much of its original earthly bituminous constituents, that the latter, combining together with the organic and inorganic matter contained in the boiler, made a perfectly impervious cement which had prevented the contact of the water and iron, and being a bad conductor of heat, caused the iron to be overheated, and thereby weakened, the steam pressure causing the collapse. The author laid a piece of this compound on a piece of iron heated to a little over red heat, which had, however, produced no further effect than the burning of a little of the bituminous matter out of it. The collapsed plate bore evidence of having been overheated, and it was only owing to the superior quality of the iron of which the fire-boxes here as well as in the case of the Conatio were constructed, that a most serious loss of life had not taken place.

The reason why only one-half of the boiler was coated with the bituminous matter, the author attributes to the circumstance that the injured side of the boiler had on it the feed-cock, and that as the oil, passing through the latter, came first in contact with the incrustation on that half, it was absorbed before it could reach the other side of the boiler. The uninjured fire-box, however, was coated with an incrustation ¼ in. thick over the whole of it. Now this thickness of incrustation ought never to be found in a boiler which is in connection with a surface condenser, and the fact of its being there clearly afforded evidence of the engineer's ignorance both of the use of the surface condenser and of the meaning of a trifling incrustation to preserve his boiler from galvanic action and oxidation. But, as seen in the case of the Conatio, the danger is not dependent alone upon the thickness of the coating of incrustation, but chiefly on its porosity. Let the incrustation be never so thin, a bituminous substance is added to it, which binds it together so that it becomes elastic and impervious to water; the iron plate will overheat and collapse under pressure. Hence, wherever oils containing bituminous matter are allowed to pass into a boiler, it is only a question of time as to when the incrustation becomes impervious, and the fire-box under it collapses.

The author was much surprised that the uninjured fire-box in the Bergen Huns boiler had not collapsed also, more particularly as the incrustation on it was spread very evenly and closely. In boilers working in connection with open injector condensers, incrustation attains a considerable thickness in places where it cannot easily fall off. But on a cylindrical fire-box it would undoubtedly never have laid so compactly as was the case here; it would have been broken and in uneven patches. It appeared evident that some of the oil had also reached the uninjured side of the boiler, and had acted on the incrustation there. The author, therefore, would recommend precautions being taken so as not to allow these oils to enter steam boilers. There is no necessity for their use at all; a little pure rectified petroleum pumped with the feed-water into the boiler will prevent such accidents as the collapsing of fire-boxes. It will be sufficient to lubricate the internal parts of the engines, and, at the same time, will keep the surface condensers perfectly clean.

Looking at the foregoing facts, the author thinks it will not be difficult to account for the disappearance of many missing steamships. At any rate, a careful investigation into the cause of this class of accidents is a matter of the greatest importance, and the author hopes the remarks he has made may have the effect of drawing attention to the subject.

JOURNAL OF GAS LIGHTING.

PIPES FOR GAS AND OTHER PURPOSES.

(Continued from SUPPLEMENT No. 80.)

SERVICE PIPES.

THE following is a description of Cotterill's system. Figs. 21, 22, and 23, for drilling and tapping mains, without permitting the escape of gas; *a* represents a ¾-inch ordinary drill, and in working it a small hole is first punched in the main as a bearing. Then drilling begins, and when the point of the drill gets through the pipe it is removed, and the ¾-inch tube-drill, *d*, is inserted; the drilling and tapping are then completed. This drill would be used for ¾-inch holes. There is also a circular steel drill, *b*, adapted to all sizes, from 1 inch and upwards. Instead of cutting the entire center, as in the case of *a*, it makes a circular ring, *c*, and when the point gets through, the tube-drill is fixed in

FIG. 21.

the circular groove and the operation completed; *d* represents a ¾-inch steel tube drill for drilling and tapping, with the screwed end for attaching either the cock or plug; *e* is a brass cock; *f*, the plug to fix into the ratchet-brace. It is essential that the plugs fit with exactness, to give accuracy to the drill, and the working must be with care; *g* is the brass union for screwing on the cock or tube and soldering to the leaden pipe. This is used only when the service-pipe is of lead; *k* is a clamp, or three-pronged fork, hammered into the ground, and against this the ratchet-brace is affixed. Fig. 22 represents a clamp with chains to fasten round small pipes. For pipes above ground, or when the fork is inapplicable, this instrument would also be generally used. Fig. 23 is a side view, showing the practical operation of drilling and tapping. A is an end view of a 6-inch pipe, and B respresents the ratchet-brace; *d* is the tube-drill; *e*, the brass cock, when such is employed; *f*, the iron plug; *h*, the three-pronged fork; and C, an iron wedge. The steel tubes for drilling and tapping are left in the pipe, and the service-pipe attached to them, and completed.

In order to strengthen small mains at the points of junction with the services, Mr. Warner employs a segmental clip in the form of a T-piece. The clip joint is first made, and then the hole is drilled in the main, after which the service-pipe is screwed into the socket, ready tapped to receive it. Fig. 24 shows the arrangement, with the service-pipe embedded in a mixture of tar and sawdust, contained in a wooden trough.

FIG. 22.

The patent removable stand-pipe, also invented by Mr. Warner, is suitable for open market-places, fair grounds, and for other purposes, where only occasional or periodical additional public lights or connections are required. The apparatus consists of a vertical pipe, the lower end of which is fixed to the main, or to a T-clip, as above described, and the upper end to a cast-iron box, in which is fastened a plate, having a plug or valve thereon. The valve fitted to a fixed seat or plug capable of turning upon it, and is square on the outside, and of such size as to fit into a collar made to slip over it, the joint between the collar and the plug being made gas-tight by the former being forced down upon a vulcanized india-rubber washer, by certain projections coming in contact with other projections, formed in the interior of a cap, which surrounds the valve and collar before described. The top of the cover has a round hole, with a notch on its opposite sides, to admit of the projections on the collar passing through and on to the plug. To the collar is fixed the stand-pipe, which is provided with an ordinary stop-cock and gas-burner at its upper end. The action of the apparatus is simple. When it is desired to make the attachment, a stand-pipe furnished with a collar, as described, is thrust down through the cover, and, on being turned, will jam itself slightly, so as to remain firmly upright, and, at the same time, turn on the gas from the main beneath. The action of removing the pipe effectually shuts off the gas, thereby insuring great security against fraud and leakage.

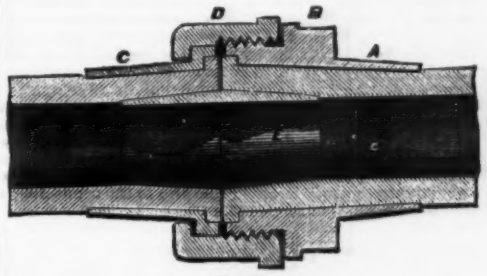


FIG. 27.

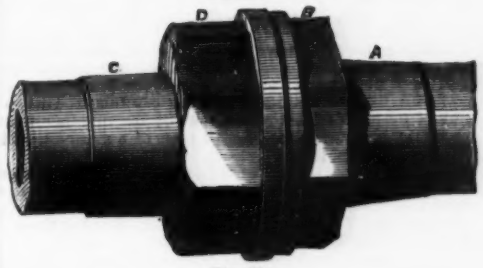


FIG. 28.

Fig. 25 represents the arrangement. The view is a side elevation and part section. To the top of the service, U, is fixed a plate, W, and upon that is fastened, by bolts, the case or box, X. To the plate, W, is also fixed, by screws, the plug or valve, Y, and upon this plug the barrel, Z, is free to turn. That part of the barrel marked *a* is square. The stand-pipe, *b*, has attached to its lower end the collar, *c*, which is square in the interior, so as to slip over and turn the barrel by the square part, *a*, until the hole in the plug and that in the barrel coincide, when a gas-way will be established between the service, U, and the stand-pipe, *b*. A gas-tight joint between the collar, *c*, and the plate of the plug or valve, Y, is made by the former being forced down upon the india-rubber washer, *d*, by the upper part of the projections, *e*, of the collar, *e*, coming in contact with inclined projections cast on the inner side of the box, X. Fig. 26 is a plan of the top of the box or case containing the valve.

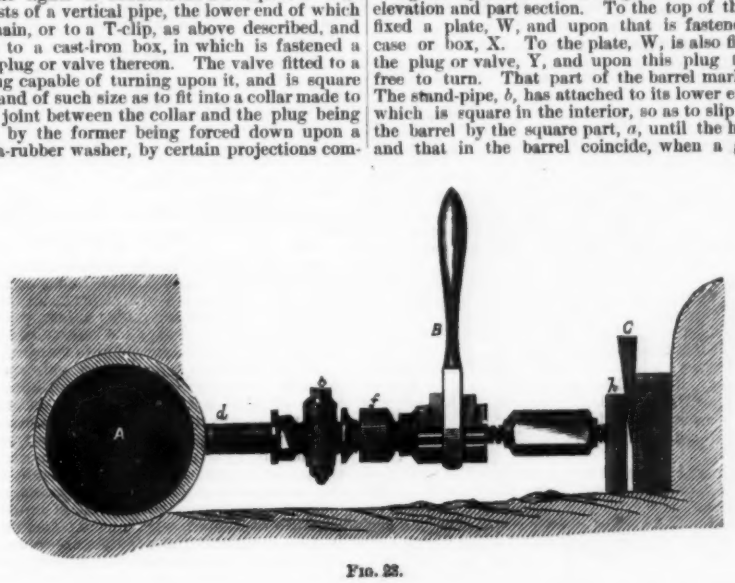


FIG. 23.

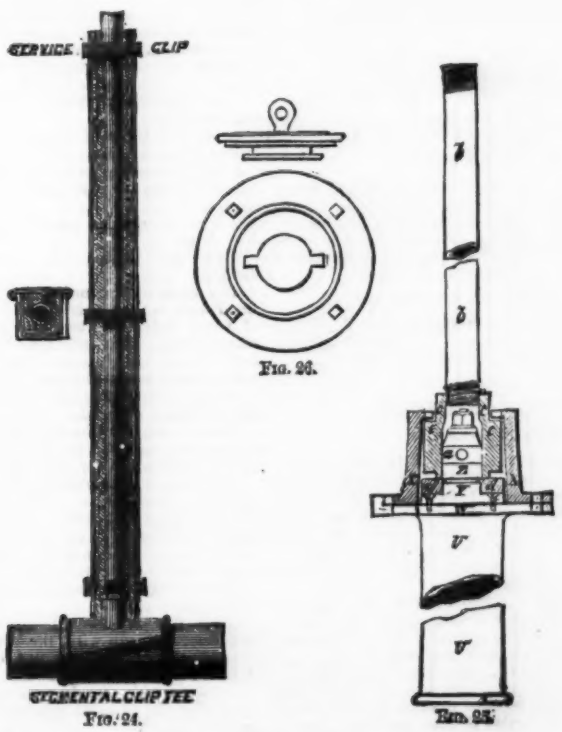


FIG. 24. FIG. 26. FIG. 25.

Various methods of coupling lead pipes, dispensing with the use of solder, have been invented. One of the best of these is that known as Leland's (American), represented in the engravings, Figs 27 and 28 being a sectional and exterior view of the joint. A is a ferrule of brass or other metal tapered inside, having an inner shoulder, a collar, B, and threaded end. The ferrule is first slipped over the end of the lead pipe, which is then opened by means of a shouldered tamp-pin, struck a few blows with a hammer, the shoulder of the tamp-pin forming a facing of the pipe against the inner shoulder of the ferrule. On the end of the other pipe, the ferrule, C, is similarly applied, secured by a shoulder on which is the other portion of the union, D. A thimble, E, of brass or iron, is then inserted in the mouth at one end, the other end is brought over it, and the union, on being screwed up, draws the parts together till the two ends of the lead pipe meet, when a gas-tight joint is formed. The time occupied in making the connection does not exceed two minutes, and it is applicable also to the connecting of lead to wrought-iron service-pipes.

PREPARATION TO SERVE INSTEAD OF ARGOL, IN DYEING WOOL WITH COLORS REQUIRING THE USE OF THE SALTS OF TIN.

By M. MALFAIT.

DISSOLVE on the the one hand 22 lbs. of alum in 70 pints of boiling water, and on the other 7 lbs. 10½ ozs. of oxalic acid in 35 pints of hot water. Mix the two solutions, and add 4 lbs. 6 oz. of acetic acid, stirring carefully. This mixture of 105 pints of hot water with 34 lbs. of other matter produces, on cooling, about 123 pints of a mordant, which costs about ten shillings.

The quantity of tartar employed in dyeing is always one-half less than that of cochineal used. To 2 lbs. 3 ozs, we take, therefore, 17½ ozs. of tartar, costing about 1s. 1d. On the contrary, if the new mordant is employed 4 litres are sufficient, which will not cost above 6d.

As the colors upon wool, for which the use of salts of tin and of tartar is indispensable, are got up with cochineal and young fustic, the only question will be the manner of working with these two coloring matters. (N.B.—The use of young fustic along with cochineal is not in England so invariable a rule as in France.)

COCHINEAL DYEING.

We begin with boiling the ground grain with the mordant in the same manner as is usually done with argol, that is to say, for 15 minutes. It is then allowed to settle, and the clear liquid drawn off. Three boilings are generally made, but only the two first are employed for scarlets and other such colors, whilst the third, but feebly charged with coloring matter, is placed in reserve, and is used merely to redden shades whose principal coloring matter is something other than cochineal, such as salmons, orange-yellows, etc. To 2 lbs. 3 ozs. cochineal we take 7 pints of the mordant, and add 35 pints of water. After the first boil, we merely boil the cochineal again with 35 pints more water, and we operate in the same manner with the residue derived from the second boil, adding in both cases no more mordant.

We then make up the beck with the solution of cochineal thus obtained and the tin composition, and work the wool in it at 150° F., till it takes the desired shade. If the shade is rather yellowish, we add to the beck a little young fustic; if, on the contrary, it is rather red, we add a small proportion of ammoniacal cochineal, or, what is better, take the wool through a beck of hand-warm water. In either case the amount of these additions is regulated by the tone of the shade.

For amaranths and crimsons we use ammoniacal cochineal, which, according to proportion, gives shades more or less tending to a violet.

We may also dye the wool by entering it at once in a beck made up of mordant, tin composition, and ground cochineal; but the shades obtained in this manner are not as bright. Before making use of the cochineal, it is therefore better to exhaust it with the mordant as described above.

The following, then, are the proportions to be used:—

Ground cochineal	3 lbs. 7 ozs.
Mordant	11½ pints.
Tin composition.....	3½ pints.
Water	210 pints.

The necessary quantity of water is added to the beck, and the wool is worked for 45 minutes at 158° to 176° Fah.

DYEING WITH YOUNG FUSTIC.

The mordant, the tin composition, and the young fustic are put in the beck together in suitable proportions. A decoction of the ware is most commonly employed, and for this purpose we boil for 1½ hour 110 lbs. of young fustic in chips with 875 pints of water. If the shade required is reddish, a small quantity of ground cochineal may be added.

PREPARATION OF THE TIN COMPOSITION.

Dissolve gradually, at common temperatures, 22 lbs. of tin, in rods, in a mixture of 70 pints of commercial spirit of salt and 35 pints of nitric acid.—*Teinturier Pratique.*

FIXING INDIGO ON TISSUES.

By M. PRUD'HOMME.

INDIGO may be fixed on printed tissues in divers ways, but the principle which presides over this fixation is one and the same, and may be expressed thus: reduce the indigo blue to a state of white indigo, soluble in alkalies, capable of penetrating the fibre, then let it remain there imprisoned whilst repassing by an ulterior oxidation to the state of indigo blue. The industrial processes employed realize all these conditions, but in different ways.

China Blue contains blue in a fine powder. The printed goods pass alternately into baths of sulphate of iron and of slaked lime. We enter thus into the conditions of the most common indigo vat, that of copperas and lime.

Fast Blue, properly speaking, contains a precipitate of white indigo and oxide of tin. The process, in this case, may be reduced to a simple passage in milk of lime, which dissolve white indigo and carries it into the fibre. An exposure to running water effects the reoxidation or the degreening of the blue. We merely remind the reader of pencil blue, where we print the vat of reduced indigo, conveniently thickened.

Finally, indigo steam blue, like the latter, carries with it all the elements of the color. The indigo may be found here previously reduced. The color should in all cases contain an excess of reducing mixture, which will act at the moment of steaming. The conditions which a good steam blue should combine, and which industrially are still to be found, have been clearly defined by M. Schutzenberger, when he calls for the discovery of a combination which would permit to print indigotine and to render it momentarily soluble on tissue, under the influence of steam. An alkaline reducer, adds he, which would not act in the cold, but only in the heat, during the steaming, would fulfil this object.

The blue which most approaches these conditions that of M. C. Zurcher, composed of indigo blue, alkaline carbonate, and oxide of tin in paste. Unfortunately, the results which are obtained on the large scale with this process are not very satisfactory.

There are few coloring matters as ancient as indigo, few which have given rise to more researches. Nevertheless, a few years ago, MM. Schutzenberger and Lalande succeeded with a new and powerful reducer, hydrosulphite of soda, in fitting up a vat of indigo, which has since received the striking confirmation of industrial practice on a large scale. We have discovered recently a new method of the reduction and fixation of indigo, which, without great practical importance, nevertheless presents some interesting peculiarities.

A mixture of glycerine, carbonate of soda, and protoxide of tin in paste reduces perfectly warm indigo. The reduction is complete towards 248° Fah. The same elements, if water is used instead of glycerine, only yield an incomplete reduction. How do we explain this reaction?

The carbonate of soda decomposes in presence of oxide of tin to form stannite of soda. The liquid becomes strongly alkaline, and the soda set at liberty reacts on the glycerine, giving a mixture of acetate and formiate, with disengagement of hydrogen.

We have directly verified that soda and glycerine, heated together, reduce indigo very well. To this action is joined another. Oxide of tin in paste and glycerine reduce indigo in heat, probably by an analogous process.

If we take account, besides, of the solvent properties of glycerine, which serves as a vehicle to the oxide of tin to bring it better in contact with the indigo, we conceive that all these conditions, reunited, make a mixture of which we speak an excellent reducer. Let us come to print a mixture of blue indigo, of tin, and carbonate of soda, and to pass the tissue in glycerine heated up to 248° Fah., the indigo is reduced, and by withdrawing in time the fibre from the action of glycerine to prevent it running in the bath, we obtain, by reoxidation in air, indigo blue.

M. Jeanmaire has already stated that on cloth prepared with glycerine, indigo blues gain in intensity. The reducing elements which it contains make of it a sort of fast blue. Finally, the raised temperature necessary for the reaction and the fixation of the coloring matter would almost assimilate it to a steam blue.—*Moniteur Scientifique.*

CLEANSING TISSUES WITH MINERAL OILS.

By M. ZAENGERLE.

SOAP has been till lately the principal agent employed for cleaning woven goods, both for domestic and manufacturing purposes. This use, which depends on the property which it possesses of disolving fatty matters, can only be applied to articles of a simple make, and especially to fast colors, if we do not wish them to become impoverished.

Every one knows that when garments are sent to be cleaned, trimmings, embroideries, ribbons, and ornamental work of wool, silk, fur, etc., must be taken off. To obviate this inconvenience, agents have often been sought for which might supersede soap without requiring the same precaution. The attempt has been successful with the volatile products extracted from petroleum, and known under the names of naphtha, benzine, ligroine, etc. The so-called "dry cleaning" effected with these liquids is applicable to all sorts of tissues, whether the colors be fixed or fugitive. It does not affect the peculiar appearance of each tissue, and succeeds with all articles, whether trimmed or not, always excepting certain cotton articles, such as stockings and under-waistcoats of light colors.

M. Zaengerle describes a method of cleaning in use at Berlin, and depending on the employment of mineral oils. It is due to M. H. Droesse.

The articles to be submitted to this process must be first classed and assorted as follows:

1. Garments of white silk or of very light patterns in the same material.
2. White articles of wool, or mixed wool and cotton, or those of the same material in which white predominates.
3. Velvets and other silken articles of the same class.
4. Garments of pure wool, or wool and cotton of light shades.
5. Woolen articles of deep colors and mixed tissues, if very dirty.

These are treated one after another in the order indicated.

The apparatus consists of a fixed outer casing of wood lined with zinc or galvanized iron, in which turns a drum of wood formed of two end pieces connected by wooden ribs or bars. The drum may be moved by an axle placed horizontally, which passes through the outer case, and carries a pulley over which passes a driving-band. The whole is so arranged so that the box may be easily and rapidly opened and the drum charged.

The operation begins by introducing the liquid to be used in cleaning, naphtha, benzine, or ligroine, so that the drum may plunge into it for some three to four inches.

The articles to be cleaned are then taken and spread upon a sloping zinc table, fitted with a ledge, and are then well brushed with a brush well saturated with the detergent liquid. It is easy to see that the nature of the goods to be cleaned must regulate the hardness of the brush to be used as well as the force and duration of the friction. The liquid which flows off is conducted by a gutter into a vessel placed for the purpose.

After this brushing, the articles are put in the drum, selecting, to begin with, the articles of the first class. If these are laces, or other fine objects capable of escaping between the bars, they should be previously enclosed in a net. After this the box is closed, and the drum made to revolve for 25 to 30 minutes, at the rate of 20 turns per minute.

The articles of the second class may have 25 turns per minute for half an hour. They will have been brushed whilst the first lot was revolving, and for them the liquid may be used which ran off during the brushing of the first lot. After the first lot has been withdrawn from the drum the second lot may be at once entered without renewing the naphtha, etc.

The articles of the third class must not have more than 8 to 12 turns per minute for half an hour; those of the fourth lot turn likewise for half an hour, but at the speed of 25 turns a minute; and those of the fifth class rotate at the same speed but for three-quarters of an hour. Each lot must be brushed whilst the former one is turning, and the five classes will all in succession pass into the drum without any change in the liquid.

As each charge is withdrawn from the drum it is placed in a wooden vat lined with zinc, and containing pure, clear liquid, to be rinsed; after which the articles are whizzed with the greatest energy compatible with their strength and texture. It is required, in fact, to extract from them the largest possible quantity of naphtha or benzine without the risk of tearing them. The liquid which flows from the centifugal may be poured into the washing machine. Velvets bear whizzing worse than any other goods.

As soon as they are withdrawn from the turbine, the objects are taken to a drying stove, and submitted to the most elevated temperature which they can bear without injury.

By following in the treatment of goods to be cleaned the progressive course just described, the liquid may be used till it becomes quite black. After which it may be allowed to settle in the closed washing machine, when a clear and pure stratum rises to the top and may be immediately decanted, and can be at once used again. Nevertheless, at the end of several operations the detergent liquid becomes finally turbid, yellow, and dirty, and can only be purified by distillation. (It may be doubted whither it will be worth the time and trouble of the garment-dyer to perform this operation, except he works upon a very large scale.)

The cleansed articles are withdrawn from the stove after an hour or two completely dry and inodorous, and then looked over to see if they retain any saccharine or amylaceous spots.

Such stains are easily removed by means of gentle friction, after spreading the articles upon a waxed cloth, applied with a sponge or with a brush, hard or soft, according to the texture of the articles. Those of cloth, compact wool, etc., may be simply brushed with clear, cold water; those of silk, more or less fragile, must be carefully rubbed with pure water, mixed with a little alcohol or acid according to the nature of the colors. This moistened spots are then immediately rubbed dry with a very clear skin, and then dusted over with gypsum in an impalpable powder (we should rather recommend magnesia) to prevent the formation of a dark ring round the spot. When thoroughly dry this powder is removed with a soft and very clean brush, and if some traces remain they are carefully effaced with the crumb of stale bread.

All these manipulations should leave no trace nor injure the freshness of the colors.

Sometimes the dry cleansing process leaves unremoved traces of stearine and of sealing wax; these may be removed with alcohol.

It is not the same with old spots of oil paint, which are exceedingly tenacious; it is necessary to dissolve them with the finest olive oil; this operation is long, and renders it necessary to pass the garment once more through the cleansing process above described to remove the oil, which has dissolved the paint.

In severe weather the naphtha, benzine, etc., may be carefully warmed.

The great inflammability of all these liquids makes it needful to proscribe all fires and open lights in the workroom. If heat is required it must be obtained by means of a steam-pipe.—*Dingler's Polytechnisches Journal.*

NEW YORK handles about five thousand alligator skins per annum. The business is entirely in the hands of a single firm, who employ men to pursue the reptile in the bayous of the Mississippi river, and the work is usually done at night by the aid of lanterns, the rifles used being aimed straight at the creature's eyes. If the alligators are too old or too young, the ammunition used on them is thrown away, for in such cases the skin is either too horny or too small. A good size is eight or nine feet, counting nothing beyond the thick part of the tail. Florida is a great place for alligators, but skins from that direction are badly mangled, indicating strong objections by the animal against parting with his natural integument. The market price for finished skins in New York is $36 to $48 per dozen; extra, something higher; raw, according to condition.

SOLDERING SILVER.—The best solder for general purposes, to be employed in soldering silver, consists of 19 parts (by weight) of silver, 10 parts of brass, and 1 of copper, carefully melted together and well incorporated. To use this for fine work it should be reduced to powder by filing; the borax should be rubbed up on a slate, with water, to the consistence of a cream. This cream should be applied with a fine brush to the surfaces intended to be joined, between which the powdered solder or wire is placed, and the whole supported on a block of charcoal to concentrate the heat. In the hands of a skilful workman the work can be done with such accuracy as to require no scraping or filing, it being only necessary to remove the borax when the soldering is complete by immersion in jewellers' pickle.—*Watchmaker and Jeweler.*

CHEMISTRY AND MINERALOGY.

The Attraction and Repulsion of Bubbles by Heat.—Mr. Hartley, of King's College, communicated to the Royal Society last month some interesting results of a long series of experiments on the bubbles in the fluid cavities of quartz, and others observed in sections of granite. He finds that those bubbles are attracted by a source of heat, and that under certain conditions they may be repelled. A rise of temperature, amounting to 5° or 6° C., causes attraction, and an increase of 0°·5 C. will in some cases produce repulsion. In certain instances the same bubble was repelled under ordinary conditions, but attracted if its temperature was raised to 60° C., the source of heat being always from 0°·5 to 5° C. warmer than the specimen operated upon. These phenomena, moreover, were observed in the case of cavities containing liquid carbonic acid, as well as water; and the exposure of carbonic acid to a temperature higher than that of its critical point did not affect the result. This affords a means of controlling to some extent the conditions of the experiment, since carbonic acid, when it just passes the critical point, exerts a tension of 109 atmospheres. The author considers the explanation, proposed by Profs. Tait and Swan, of the movement of bubbles in the cavities of calcite, noticed by Mr. Sang, of Edinburgh, to be insufficient; and, after showing that the warmth of the finger can propel even in a vertical direction a plug of water in a capillary

tube, refers the attraction of bubbles to the cause which occasions this movement. In communications addressed to Mr. Hartley, Prof. Stokes regards this *repulsion* of the *liquid* to be due to a decrease of surface-tension at one side of the plug of liquid in the tube, or at one side of a bubble in a cavity, a result in each case of a fall of temperature. When repulsion of a bubble, or *attraction* of the *liquid*, occurs, it is owing to a slight rise of temperature, which effects a disengagement of gas from the water on the side of the bubble nearest the source of heat, and that increases the surface-tension at this side; the bubble, therefore, is propelled in the opposite direction. As these explanations meet every fact which Mr. Hartley has noticed, he has abandoned his own theory regarding the movement, a theory, it may be stated, with which he was entirely satisfied. In a paper recently read before the Chemical Society, Mr. Hartley states that some of the bubbles in water-cavities, with a rise of temperature, become denser than water and sink. He refers to a cavity in a crystal of quartz, occurring in a specimen of felstone, which was found by Mr. Young to contain a moving particle, supposed to be a bubble, which made its appearance only in a cold atmosphere. At 3°·5 C. the cavity had the appearance of being two-thirds filled with liquid, the gas-bubble occupying the remaining space exhibiting a kind of trembling motion; as it decreased in size, the motion became more and more rapid, until it rushed across the space confining it. The thought suggested itself that this was not a gas-bubble, but liquid in a spheroidal condition; and repeated experiments showed it to be a bubble of liquid carbonic acid. The size of these bubbles was about $\frac{1}{2500}$th of an inch in diameter; the motion becomes very slow in the case of bubbles $\frac{1}{7500}$th of an inch across. Mr. Hartley believes that these vibratory motions afford an ocular demonstration of the continual passage of heat through solid substances, and apparently make the molecular vibrations of matter plainly visible.

Can Gases Permeate Glass?—All bodies are generally assumed to be porous. Of the magnitude of their pores, or of the size of the molecules constituting the bodies themselves, we know next to nothing. It appears possible that molecules of complex constitution, especially such as have great molecular weight, may occupy more space, and form material with larger pores, than others with less molecular weight would fill and constitute. A hydrogen molecule, then, of all others, would occupy the least space, and it appeared to Quincke as not improbable that the particles of this element might be able to pass through the pores of solid substances such as glass. Although this view hardly appears to be in accordance with the generally received hypothesis respecting the properties of gases, the question whether those substances can traverse the pores of glass could only be decided by experiment. The author describes (*Pogg. Ann.*) the results of a number of experiments which he has made in this field. He has tried whether, in the course of years, hydrogen and carbonic acid, under the pressure of 40 to 120 atmospheres, could pass through a glass wall 1·5 millimetre in thickness, and whether the amount of permeated gas could be determined on the balance by a loss in weight of the apparatus. Hydrogen was generated, from zinc and sulphuric acid, in a series of closed glass tubes, and the pressure in each case observed by the change in the volume of the air of an inclosed capillary tube, which served as a manometer. During the first few days the pressure in the tubes was from 1½ to 10 atmospheres, at the end of five months it attained to from 27 to 54 atmospheres, and in seventeen years it rose in one case to 126 atmospheres. The tubes were weighed from time to time on a very accurate balance, and in no case did their weight vary beyond 0·1 to 0·3 milligramme. In a tube charged with carbonic acid, generated from lime and sulphuric acid, the pressure was observed during the first few days to amount to 21 atmospheres, rose at the end of five months to 34 atmospheres, and after seventeen years reached a pressure of 44 atmospheres; the tube preserved during this time one and the same weight. A pressure, therefore, of from 40 to 120 atmospheres, maintained over the long period of seventeen years, is not sufficient to drive an appreciable amount of hydrogen or carbonic acid through glass 1·5 millimeter in thickness. It was remarked in the second case that the concentrated sulphuric acid flowed through the condensed carbonic acid as mercury moves in a glass tube filled with air. The author concludes his paper with a consideration of the probable size of molecules.

Succinic Acid in the Juice of the Unripe Grape.—Brunner and Brandenburg have sought for glyoxylic acid and desoxalic (racemocarbonic) acid among the constituents of the juice of the unripe grape (*Zeitschrift fur anal. Chemie.*, 1877, xvi., 246). Fifty pounds weight of the fruit, gathered in the middle of June, supplied the material. The expressed liquid was directly treated with excess of lime carbonate, and the protein compounds having next been rendered insoluble by raising the filtrate to the boiling point, the filtered liquid was evaporated to as small a bulk as possible. After treating the residue with animal charcoal, a crystalline substance was obtained, which, when purified, was found, on analysis, to be lime succinate. The acids above referred to were not met with, and the authors ascribe their failure to detect their presence to the possibility of the grape having reached too advanced a stage of development; and they intend to examine the fruit at an earlier period, immediately after flowering. Should they prove successful in showing glyoxylic acid to be a normal constituent of the plant, a conception of the gradual conversion of carbonic acid into the vegetable acid under the reducing action of light may be arrived at—a conversion in accordance with experiments which can be performed in the laboratory. We might then regard the acids referred to, and others met with in vegetable tissues, to be successfully derived from a hypothetical carbonic hydrate, in the following way:

$$2(CH_2O_3) + H_2 = \underset{\text{Oxalic Acid}}{C_2H_2O_4} + 2H_2O$$

$$C_2H_2O_4 + H_2 = \underset{\text{Glyoxylic Acid}}{C_2H_2O_3} + H_2O$$

$$C_2H_2O_3 + H_2 = \underset{\text{Glycollic Acid}}{C_2H_4O_3}$$

$$2(C_2H_2O_3) + H_2 = \underset{\text{Tartaric Acid}}{C_4H_6O_6}$$

$$C_4H_6O_6 + H_2 = \underset{\text{Malic Acid}}{C_4H_6O_5} + H_2O$$

$$C_4H_6O_5 + H_2 = \underset{\text{Succinic Acid}}{C_4H_6O_4} + H_2O$$

Neubauer detected oxalic acid in vine leaves, and found abundance of this acid, as well as some malic acid, in wines of bad vintages, like that of 1871. Malic acid is not met with in wines of good vintage, but it occurs plentifully in the leaf of the vine at a certain stage of growth. Moreover, Neubauer found succinic acid in the spring sap of the vine, and Gorup-Besanez detected the presence of glycollic acid and malic acid in the leaves of the Virginia creeper (*Ampelopsis hederacea*) (*Academy*, 1872, iii., 172). Glyoxylic acid is the only member now wanting of this interesting series.

The Occurrence of Hydrosulphites in Human Urine.—Schmiedeberg and Meissner found this acid to be an almost constant constituent of the urine of the cat, and to be frequently present in that of the dog. Strümpell (*Zeit. fur anal. Chemie*, 1877, xvi., 134) has now detected its presence in that of a patient suffering from typhus fever. He was led to search for this acid through his attention having been directed to an unusual reaction which the liquid exhibited with silver-solution during a volumetric determination of the chlorine, a reaction which those who perform analyses of this kind would do well to study. He found in the case which he examined that 1·5 gramme of sulphur passed from the body every twenty-four hours in other forms than that of a sulphate. Calculated as hyposulphite it would amount to a daily yield of 2·25 grammes of this salt.

Action of Trimethylamine on Metallic Salts.—C. Vincent has pointed out (*Bull. Soc. Chim. Paris*, xxvii., 194) the importance of this body as a reagent. It can easily be prepared; and it differs in its reaction in many important respects from ammonia. The white gelatinous precipitate which it forms in aluminium salts dissolves in an excess of trimethylamine. The salts of cobalt, nickel, copper, and zinc form precipitates which are insoluble in an excess of the reagent. Silver salts throw down a dull-gray precipitate, soluble in a large excess of trimethylamine; the chloride of that metal, however, is quite insoluble in it.

The Bismuth Mine of Tasmania.—Ulrich has communicated to the *Berg- und Huttenm.-Zeitung*, xxxv., 447, a report on the occurrence of this metal at Mount Ramsay, and of the processes employed to extract it. It is met with as metal in a gangue in granite, or in a hornblende rock, either in irregularly-shaped grains or crystalline, and associated with gold, arsenical pyrites, copper pyrites, magnetite, ilmenite, scheelite, fluor, and axinite. The ore cannot be worked profitably for copper; it contains, however, 3 per cent. of bismuth, which, as well as the gold, are of considerable value.

[NATURE.]

CHEMICAL NOTES.

CRYSTALLIZATION UNDER GALVANIC CURRENTS.

A RECENT number of the *Journal* of the Russian Chemical and Physical Society (vol. ix., fasc. 2) contains an interesting report, by M. Shidlovsky, on observations he has made as to the microscopical crystallization of various metals under the influence of a galvanic current. Placing on the object-glass of the microscope two fine metallic plates, the edges of which are about a quarter millim. distant, immersing them in a drop of water and passing a current through, M. Shidlovsky watched the growth of small ramified threads of crystals of metal transported from the cathode to the anode plate. The growth of these tree-like agglomerations goes on very speedily; their branches spread out to the anode plate, vibrate on reaching it, and collapse, whilst another ramified tree grows from the cathode spreading out to the anode; this goes on until the space between the plates is filled with a spongy metallic mass. Each of the metals experimented on (lead, silver, zinc, tin, copper, and iron) gives its own characteristic ramifications, and if the two plates be of different metals the tree has ramifications characteristic of the metals of which the anode plate is made. Gold and platinum do not exhibit any appearance of crystalline trees, nor does the crystallization appear when the anode is gold or platinum. Iron submitted to a continuous current does not show a transport of crystals, but the phenomenon appears immediately when the currents are originated by a Ruhmkorff's coil or by a Holtz' machine. Iron-powder suspended in water undergoes a rapid motion under the influence of a strong inductive current, forming threads which spread out from the cathode to the anode plate.

ISODIBUTYLENE.

The same volume contains the second part of the important paper, by Prof. A. Butlérof, on the polymerization of hydrocarbures from the ethylene series: On isodibutilene.

ON THE THERMIC FORMATION OF OZONE.

M. Berthelot has recently investigated this question by subjecting pure and dry oxygen to the influence of the silent discharge, whilst passing the gas into a flask containing 500 c. c. solution of titered arsenious acid. At the end of thirty minutes, six to nine litres of oxygen had passed though the flask, the temperature being raised one-third of a degree, then, by passing the oxygen current without the action of the discharge for an equal time, the thermal data were rendered complete. The arsenious acid solution was then treated with potassium permanganate, and redetermined with a solution of oxalic acid. By this means the quantity of arsenious acid oxydized, and codsequently ozone absorbed, was determined. The amount of oxygen absorbed was found to be 30·3 and 51·9 milligrams, corresponding to 90·9 and 155·7 m.m. ozone, the heat set free being 118·2 and 223 calories respectively. Hence for one molecule the heat is equal to + 68·8 calories. Subtracting from this the heat formed in the oxidation of a molecule of arserious acid, + 39·2 calories (Favre and Thomsen), we have + 29·6 calories for the heat set free in the condensation of one molecule ozone into oxygen, and consequently — 29·6 in the reverse process. Ozone therefore is a body in which heat is absorbed in its formation, its activity in combination being probably due to this heat being set free. This is worthy of note when it is remembered that it is condensed oxygen, condensation generally setting free heat.

CHLOROPHYLL IN CONIFERÆ.

Coniferæ are remarkable, amongst other plants, for developing their chlorophyll, even in places which seem perfectly dark. In the Reports of the *Naturforschende Gesellschaft* of Leipsig, Herr R. Sachsse publishes the results of some investigations he made in order to ascertain whether the chlorophyll formed under the circumstances is quite identical with ordinary chlorophyll. He extracted the young coniferæ, which had germinated in the dark, by boiling them in alcohol. He obtained a solution which showed the ordinary chlorophyll spectrum; all bands were in the right position and showed the correct grades of intensity. When the solution was concentrated the absorption at the end of the spectrum was continuous, when more diluted the absorption was resolved into the well-known three bands. The only peculiarity in this spectrum, when compared with that of chlorophyll of ordinary origin, was the somewhat lesser intensity of band V. According to Kraus' idea, this would prove a predominance of cyanophyll over xanthophyll. The solution of coniferæ chlorophyll very readily turns to modified chlorophyll.

CHEMISTRY OF THE GRAPE.

In several treatises lately presented to the Royal Academy of Physical and Mathematical Science of Naples, Prof. G. Licopoli gives account of some recent micro-chemical researches upon oranges, lemons, and grapes. The latter are of special interest, as Prof. Licopoli tried to determine the time and place at which, in the grape, the different chemical substances which are contained in it (such as tartaric acid, chlorophyll, albuminoid matter, sugar, coloring matter, etc.) first begin to form. The conclusions which the author draws from his labors are the following: Tartaric acid and chlorophyll first show themselves in the tissue of the pistils in course of formation. Oxalate of lime next shows its presence in the sub-epidermic tissue in the form of raphides, in the endocarpic epidermis in the shape of conglomerated crystals (dumb-bells?), and in the kernels in raphides. The albuminoid matter first appears spread over the whole of the fruit, but predominates in the mesocarp. Coloring matter results from the metamorphosis of chlorophyll, its appearance and diffusion showing the growth of the fruit, and the progress the chlorophyll has made at the time of its formation. The growth of this coloring matter begins in the peripherical tissues, and continues towards the central ones. Sugar is found in the pericarp wherever there is tartaric acid present. Resinous matter or wax appears first on the surface of the epicarpic epidermis. Tannic acid is principally formed in the seed, and particularly in the hard and finder part of the episperma; the fibro-vascular fascicles of the pericarp, however, also contain this acid.

BLACK OXIDE OF MANGANESE AS A DISINFECTANT.

By J. DE VALMAGINI.

IT is well known that ozone is the only substance which rapidly decomposes evil smelling gases; but up to this time we possess no method of preparing ozone cheaply and in large quantities. I have found by a series of experiments that ozone is present in black oxide of manganese (*Braunstein*) in large quantities, and that it is continually regenerated. It was not hitherto known that many kinds of oxide of manganese (manganite, pyrolusite, etc.) were ozone carriers; but I can prove that they not only possess all the properties of the known ozone bearers, but are excellently adapted to use in all cases where ozone has proved useful.

Ozone test paper, prepared with starch and iodide of potassium, is immediately turned blue by the liberation of iodine without any acid being added.

A solution of chemically pure iodide of potassium is at once decomposed by dropping into it a fragment or some of the pulverized mineral, the liberated iodine turning the solution brown. The free iodine is recognized by all its reactions, such as turning blue with starch paste, dissolving in chloroform or bisulphate of carbon, subliming at the boiling temperature, and by its characteristic odor.

Chemically pure binoxide of manganese, prepared artificially, shows the same reaction in chemically pure iodide of potassium as given above, reacting just like the natural product.

When the pulverized mineral is strewn upon chemically pure silver and moistened, the silver is browned at once by the formation of oxide of silver; on heating, the brown spot entirely disappears, proving that it was not sulphide of silver which was formed.

The air is also ozonized by contact with the surface of the mineral or of the powder.

The reaction about to be mentioned now was indeed known, but was never considered as an ozone reaction, namely, tincture of guaiacum is colored deep blue by the oxide of manganese.

Black oxide of manganese is also well adapted, by its ozonizing power, to destroy putrid gases, such as sulphuretted hydrogen, and putrefactive gases, and that very rapidly.

From this it may be concluded that many kinds of manganese ores could meet with extensive use for sanitary and building purposes.—*Bayerisches Industrie und Gewerbeblatt.*

A NEW STIMULANT—PITURY.

BARON VON MUELLER writes to the *Australian Medical Journal* on the origin of the pitury, a stimulant said to be of marvellous power, and known to be in use by the aborigines of Central Australia. After years of efforts to get a specimen of the plant, he had obtained leaves, but neither flowers nor fruits. He can almost with certainty, after due microscopic examination, pronounce those of the pitury as derived from his *Duboisia Hopwoodii*, described in 1861 (*Fragm. Phytogr. Austr.* II., 138). The bush extends from the Darling River and Barcoo to West Australia, through desert scrubs, but is of exceedingly sparse occurrence anywhere. In fixing the origin of the pitury, a wide field for further inquiry is opened up, inasmuch as a second species of *Duboisia* (*D. myoporoides*, *R. Br.*) extends in forest land from near Sidney to near Cape York, and is traced also to New Caledonia, and lately by him also to New Guinea. In all probability this *D. myoporoides* shares the properties of *D. Hopwoodii*, as he finds that both have the same burning acrid taste. Baron Mueller adds: "Though the first known species is so near to us, we never suspected any such extraordinary properties in it as are now established for the later discovered species. Moreover, the numerous species of the allied genus *Anthocercis*, extending over the greater part of the Australian continent and to Tasmania, should now also be tasted, and, further, the many likewise cognate *Schwenkeas* of South America, should be drawn into the same cyclus of research, nothing whatever of the properties of these plants being known. The natives of Central Australia chew the leaves of *Duboisia Hopwoodii*, just as the Peruvians and Chilians masticate the leaves of the Coca (*Erythroxylon Coca*), to invigorate themselves during their long foot journeys through the deserts. I am not certain whether the aborigines of all districts in which the pitury grows are really aware of its stimulating power. Those living near the Barcoo travel many days' journeys to obtain this, to them, precious foliage, which is carried always about them, broken into small fragments and tied up in little bags. It is not improbable that a new and perhaps important medicinal plant is thus gained. The blacks use the *Duboisia* to excite their courage in warfare; a large dose infuriates them."

THE FLOW OF SOLIDS.

By LEWIS S. WARE, C.E.

IT is a comparatively recent discovery that solids as well as liquids are possessed of fluidity under favoring circumstances, but the investigations in this direction have not been numerous. Much attention was given to this subject by M. Tresca of the Conservatoire des Arts et Métiers in Paris. Having witnessed some of his experiments and seen the results of others, I have thought a statement of them would be of interest to the general reader and of value to workers in metal, who, though most frequently using solids not in this condition, yet very often having to deal with this flow, it is highly important that they should know the laws which govern it. These laws are but little known, and for that reason the experiments of M. Tresca, will help to fill a space up to the present time greatly neglected. Those who visited the Centennial Exhibition saw various machines used in piercing iron, even in plates several inches thick, apparently with great ease. I have thought it well to divide the subject into two parts.

PART I.—*Practical Experiments.*

If a cylinder of lead, three inches long, be placed between two iron plates, having each a hole ½ of an inch in diameter, the holes opposite each other; if we cause a punch to pass through first hole (plate 1) penetrating the cylinder of lead,

FIRST EXPERIMENT.

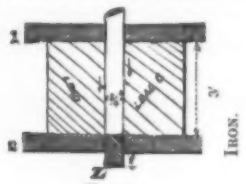


FIG. 1.

causing the expelled portion *L* to pass through the second hole in plate 2; the portion expelled will be found to have for its dimensions ½ of an inch in diameter and 1 inch in height, instead of three, as should have been if the derangement of the matter had taken place in the direction of the movement.

This phenomenon could be explained by supposing a different density, for the compressed portion; upon examination this hypothesis is found to be erroneous, and M. Tresca was the first to discover the true reason. His experiment

M. TRESCA'S FIRST EXPERIMENT.

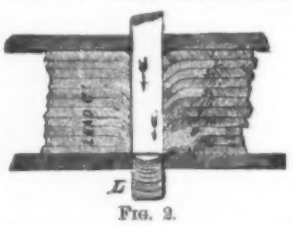


FIG. 2.

(Fig. 2) consisted in placing, instead of a leaden cylinder *C*, a series of plates of the same metal.

The punching was again begun, the portion expelled (*L*) is composed of unequal layers, each of which represents the plates (1, 2, 3, etc.). Those of the upper portion, except the first, are extremely thin and hardly visible to the eye.

We can conclude from this, that portions coming in contact with the punch, were forced back into the layers of lead.

SECOND EXPERIMENT.

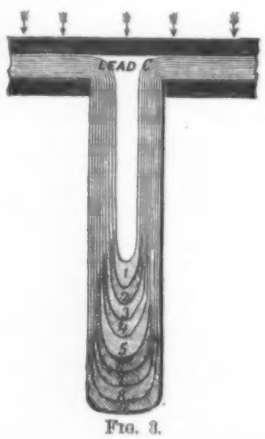


FIG. 3.

This gave the first hints of internal movements that may take place from pressure on solid masses.

Flowing of the cylinder C *through a concentric orifice* (Fig. 3).

This experiment is very much the same as those we have just examined, a piston taking the place of the punch; pressure being applied, the lead escapes through a circular orifice, having the same center as the axis of *C*. We have here

THIRD EXPERIMENT.

FIG. 4.

a jet, the shape of which is a cylinder, enabling us to obtain information in regard to the internal changes taking place in *C*.

Remark.—If the orifice in the last experiment had been a polygon instead of a circle, we should have obtained a jet, the shape of which would have been that of a polygon, having the same number of sides as the orifice; these sides become smaller, and the angles more rounded, as we approach the center, where they are replaced by an almost perfect circle. Here is a phenomenon exactly the same as the one observed by M. Bazin, in his researches on the transverse sections of flowing liquids.

When the height of the cylinder *C* (Fig. 4) is less than the radius of the orifice, there is an internal cavity in the jet, the shape of which is extremely regular, so much so, that it can easily be expressed by an equation. If we observe what takes place when the pressure becomes still greater, it will

FIG. 5.

be seen that the external appearance of the jet (Fig. 5) is the same as that of a liquid (contraction of the vein). This is the only experiment that "M. Tresca" showed me in which this phenomenon was visible.

The next two show more and more the great similiarity existing between the laws of flow of liquids and solids.

They differ from those we have examined, in the shape given to the metal before being submitted to pressure. In-

FOURTH EXPERIMENT.

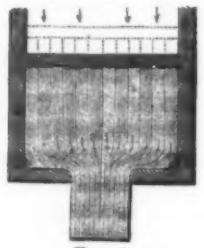


FIG. 6.

stead of plates placed one on the other, they are *concentric cylinders*. If a section through the axis of the entire mass be examined after the pressure has had its effect, it will be seen that all the molecules composing *C* have a tendency to move in the direction of the orifice, after which they move parallel with each other.

Remark.—It is a well known fact, that all calculations concerning liquids, are based on the hypothesis of parallelism of the molecules in movement.

FIFTH EXPERIMENT.

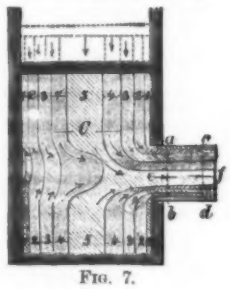


FIG. 7.

The external appearance of the vein (owing to the influence of the air friction, etc.), has a tendency to mislead the observer.

Flowing of C *through a lateral orifice.*

When the pressure is exerted on the upper part of C, it is transmitted to the interior of the mass, causing a jet to form, having a cylindrical shape, offering many interesting pecu-

VERTICAL SECTION OF JET. SECTION A B.

FIG. 8.

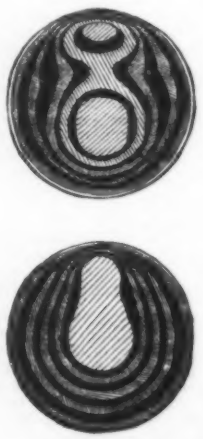


FIG. 9.

liarities. If sections be made perpendicular to the axis of the jet, it will be seen that 1, 2, 3, etc., form each a distinct portion of the total. If Figs. 8 and 9 be examined it will be found that this jet is composed of two distinct parts, one corresponding to the superior, and the other to the inferior portion of *C*.

The existence of the above can be better realized if a section perpendicular to the orifice be made (see Fig. 10).

All this movement takes place with great regularity, as shown by Figs. 8, 9, and 10.

SECTION E F.

FIG. 10.

PART II.—*Theoretical Calculations.*

I will now endeavor to show what takes place during the period of pressure; the argument will be based on two hypotheses, after which I will give an experiment, also made by M. Tresca, expressly for the purpose of determining how near these theoretical calculations are to the actual fact.

I have already stated that the volume of the jet, added to that of the cylinder, forms a quantity that is constant before

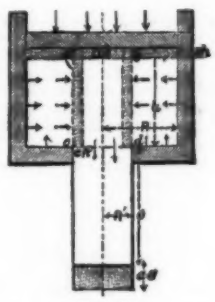


FIG. 11.

and after the pressure. In other words, a decrease of *C* will correspond to an increase of the jet, the density through the entire mass remaining the same, if we suppose that *R* is the radius of *C*, and *R* radius of orifice, *h* height of *C* at any moment during the pressure, *H* height of *C* before pressure, *l* length of jet corresponding to a pressure ($H - h$).

If we suppose a small decrease ($-dh$) in the height of *h*, corresponding to an increase (dl) in the jet, these volumes being the same, we have:

$$-\pi R^2 dh = \pi R^2 dl, \quad \ldots\ldots\ldots\ldots \text{(a)}$$

hence,

$$dh = -\frac{R^2 dl}{R^2} \quad \ldots\ldots\ldots\ldots\ldots \text{(1)}$$

The equation (1) is necessary in our future calculations.

FIRST HYPOTHESIS.—Concentric contraction of the central cylinder ($a\ b\ c\ d$), having a radius R' = to the radius of the jet.

If we admit the existence of a central cylinder, we shall have a ring which is the remaining portion of *C*, having R' for its interior, and *R* for its exterior radius

If a pressure be exerted on the upper part of *C*, at every decrease of $h = dh$, the matter composing the ring, not being able to make its escape either in the direction of the pressure, or through the sides (the latter being sufficiently strong to resist it), will have its effect on the central cylinder $a\ b\ c\ d$.

The pressure on all sides being the same, we will not be far from the truth in saying that this *central cylinder* is transformed into a new surface of revolution, having the same axis as before. The most simple of all, is to suppose that it is still a cylinder. In this hypothesis it must be admitted that a decrease of the volume of the ring, when its height is diminished $-dh$, is compensated by a corresponding increase resulting from the decrease of R' of a quantity $= dR'$.

$$\pi (R^2 - R'^2)\, dh = 2\pi R'\, dR'\, h,$$
$$(R^2 - R'^2)\, dh = 2 R'\, dR'\, h.$$

Hence,

$$\frac{dh}{h} = \frac{2 R' dR'}{R^2 - R'^2} \quad \ldots\ldots\ldots\ldots\ldots \text{(2)}$$

SECOND HYPOTHESIS.—Proportional contraction of the central cylinder.

This central cylinder, $a\ b\ c\ d$, cannot have its radius diminished unless certain movements take place in the interior of a second *central cylinder* concentric to the first, having a radius *r*.

All actions being exerted in an equal manner around its axis, we can admit that this cylinder, having a radius *r*, will be modified in its transverse section proportionally to the one it primarily had. Hence,

$$\frac{d(\pi r^2)}{\pi r^2} = \frac{d(\pi R'^2)}{\pi R'^2} \text{ or } \frac{dr}{r} = \frac{dR'}{R'} \quad \ldots\ldots \text{(3)}$$

Equation of the locus described by any given point of the convex surface of the central cylinder, having a radius R':

To obtain this equation, it will be necessary to eliminate *h*, dh, dR', between the equations 1, 2, and 3. This is done in the following manner:

If we find the integral of (a), we have $R^2 h = -R^2 l + C$, but when $h = H$, we have $l = o$; this gives $R^2 H = C$. Hence,

$$h = \frac{R^2 H - R^2 l}{R^2} \quad \ldots\ldots\ldots\ldots\ldots \text{(b)}$$

If we divide (1) by (b), we will have,

$$\frac{dh}{h} = \frac{\frac{R^2 dl}{R^2}}{\frac{R^2 H - R^2 l}{R^2}} = -\frac{R^2 dl}{R^2 H - R^2 l} \quad \text{(c)}$$

If from (3) we obtain the value dR', and substitute this in (2), it will give,

$$\frac{dh}{h} = \frac{2 R'^2}{R^2 - R'^2}\frac{dr}{r} = -\frac{R^2 dl}{R^2 H - R^2 l}$$

Hence, by integration, we have:

$$\text{Log}^{r} r = \frac{R^2 - R'^2}{2\,R'^2}.\quad \text{Log}^{r}\frac{(R^2 H - R^2 l)}{R^2 H} + C \quad (4)$$

but when $r = R$, we have $l = o$; this gives,

$$\text{Log}^{r} R = \frac{R^2 - R'^2}{2\,R'^2}.\quad \text{Log}^{r} R^2 H + C \ldots\ldots (5)$$

If we subtract (4) and (5), we have,

$$\text{Log}^{r} r - \text{Log}^{r} R = \frac{R^2 - R'^2}{2\,R'^2}.\quad \text{Log}^{r}(R^2 H - R^2 l) - \text{Log}^{r} R^2 H;\ \text{or,}$$

$$\text{Log}^{r}\frac{r}{R} = \frac{R^2 - R'^2}{2\,R'^2}.\quad \text{Log}^{r}\frac{(R^2 H - R'^2 l)}{R^2 H} \ldots (6)$$

This equation can be written in the following manner:

$$\frac{r}{R} = \frac{(R^2 H - R'^2 l)}{R^2 H}^{\frac{R^2 - R'^2}{2\,R'^2}}.$$

The equation (6) can be written under another form more convenient for the study of the curve it represents:

$$\text{Log}\frac{r}{R}\frac{2\,R'^2}{R^2 - R'^2} = \text{Log}\frac{R^2 H - R'^2 l}{R^2 H}$$

or

$$\left(\frac{r}{R}\right)^{\frac{2\,R'^2}{R^2 - R'^2}} = \frac{R^2 H - R'^2 l}{R^2 H}.$$

This curve having for its axis of co-ordinates $o\,x$ and $o\,y$, r will be the abscissa and l the ordinate. Hence (see Fig. 12),

$$\left(\frac{x}{R}\right)^{\frac{2\,R'^2}{R^2 - R'^2}} = \frac{R^2 H - R^2 y}{R^2 H}.$$

DISCUSSION.—The nature of this curve varies with the exponent $\frac{2\,R'^2}{R^2 - R'^2}$. If $R'^2 = R^2 - R'^2$, or $R'^2 = \frac{R^2}{2}$, the curve is a parabola of 2d degree; if $2\,R'^2 = R^2 - R'^2$, or $R'^2 = \frac{R^2}{3}$, we shall have a right line. All quantities given to $2\,R'^2$ smaller than $(R^2 - R'^2)$, the curve will be a hyperbola, the degree of which is variable and becomes of the 2d degree, when $2\,R'^2 = -(R^2 - R'^2)$. But we should then have $R'^2 = -R^2$, which would give for R' an imaginary quantity.

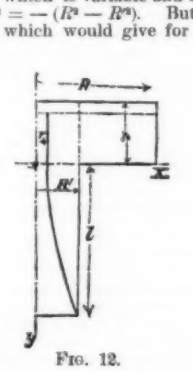


FIG. 12.

EXPERIMENTAL VERIFICATION (Fig. 13).—The cylinder C is composed of two kinds of plates; the lower two occupying the total space having a radius R: those placed on top being rings, their exterior radius is R, and interior, R' = to the orifice = 0 5 of an inch,

In this open space having a radius R', M. Tresca placed a cylinder of lead exactly fitting this representing the supposed

EXPERIMENTAL VERIFICATION.

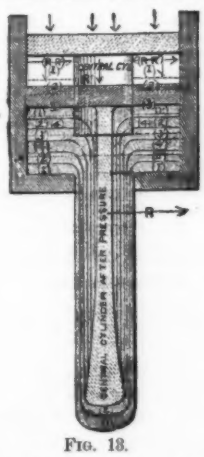


FIG. 13.

central cylinder). After the pressure had been exerted, a vertical section was made through the cylinder C and the jet; thus permitting a comparison between the theoretical equation and the actual fact.

In all the experiments made by M. Tresca, no difference greater than $\frac{1}{10}$ of an inch was found

This verification is a strong proof of the exactness of the theory of the flowing of solids.—*Journal of the Franklin Institute.*

THE difficulty of keeping a fluid free of living germs has misled many physicists who attempted to prove spontaneous generation. Thus, if a liquid be boiled for a considerable length of time, the younger germs will be killed, but the older ones will only be softened, and not devitalized. Only by successive boilings can all the germs of varied ages be killed, and a sterile fluid, suitable for the crucial test, be obtained.

[GARDENERS' MONTHLY.]

FLORAL AND HORTICULTURAL NOTES.

THE many who admired the massing of the leaf plants in bedding at the Centennial grounds last year, and have endeavored to imitate it this, will do well to remember, that just now much pinching in of the young shoots has to be done. It is the new growth made this month that gives the best colors in August and September, and this reminds us the Salvias were also pinched in; but where a fine early bloom of scarlet sage is desired, they should have no pinching back.

All who have given attention to hardy shrubs know how unsightly the prevailing fashion of winter shearing—for we cannot dignify the practice by calling it pruning—renders the bushes; and yet all feel the want of some method of keeping them within bounds, and in a somewhat cultivated form. If the strong shoots are thinned out now, all this trouble is obviated. The same remark applies to street trees, and all others that it is desired to keep low and bushy to the base.

Hedges must be served in the same way. Trim off—regarding a true conical shape—all strong top shoots, and suffer the weaker and lower ones to grow as widely and freely as they will.

In many gardens there will be roses of poor and inferior kinds, or of good roses that the owner may desire superseded by better ones. This may readily be accomplished by budding or inoculating, and now and next month is the season to operate.

In almost all works on budding it is recommended to take the wood out of the bud to be inserted. This is necessary in the English climate, but unnecessary here, and never followed by practiced hands.

Amateurs may have some rare or choice shrub they may desire to increase. They may now be propagated by layers. This is done by taking a strong and vigorous shoot of the present season's growth, slitting the shoot a few inches from its base, and burying it a few inches under the soil. Anything can be propagated by layers; and it is an excellent mode of raising rare things that can be but with difficulty increased by any other.

The raising of new varieties of florists' flowers is an interesting occupation to the amateur. The process of hybridization applies to all plants as well as to grapes; but good improved kinds of some things may be obtained from chance seedlings. The finest and doublest of Roses, Petunias, Dahlias, Carnations, etc., should be selected, and as soon as the petals fade, they should be carefully removed, or they will cause the delicate organs of reproduction to decay before maturity. A flower may be so very double as not to bear seed at all, as in the case of the Gillyflower or Stock, but if the pistil remains perfect, as it usually does, seed will ensue.

Dahlia seed may be preserved till the Spring. Antirrhinum, Rose, Carnation, and such hardy perennials, should be sown soon after ripening.

Deterioration of Grasses on a Lawn.—W. N., Boston, says, that his "lawn has got annually worse and worse, until now there is little grass, and nearly all weeds. What shall I do to restore my lawn? I have no very large tract, but take much pride in it."

[This is, no doubt, a case of "lawn mower," about which we have often written. Grass cannot grow without leaves any more than other plants, and if kept cropped too close it will surely die. Then, creeping weeds which escape the mower blades take its place. There is nothing to be done but to cut higher in future. Under no circumstances go lower than half an inch from the ground.—Ed. G. M.]

Weeds in Lawns.—E. W. G., North Easton, Mass., writes: "I send you by this mail a box containing samples of two different plants or weeds that have come up over my lawn. Sample No. 1, which I have noticed for the last two years, has not been very plenty until this year; it is all over my lawn in spots, all sizes up to one foot square or more; grows so thick that it kills all the grass where it grows. I am afraid that it will spoil my lawn in a year or two. Can you tell me what it is, or in what way I can get clear of it? I never saw any of it until about two years ago. I also find that one of my friends has the same in his lawn, spots ten feet square. Is it a plant that grows the whole season or only in the Spring of the year? Can you tell me if it is likely to continue to increase and spoil my lawn? Sample No. 2 seems to be an equally fast grower, but does not injure the looks of my lawn so much; never noticed this until this year. Can you tell me anything about it?"

[The weeds were a small Veronica and the Mouse-ear chickweed. This is another case of injury from close mowing whereby the grass is enfeebled and these little weeds are able to thrive. The grass must be left longer at mowing and it will keep down these little pests without much trouble.—Ed. G. E.]

The Erythronium, or Dog's-tooth Violet.—There are few of our people who have gathered wild flowers but who know the Yellow Dog's-tooth Violet. Why it has received the name of Dog's-tooth Violet may not be well known to our readers, and the following little bit of history from the *Garden* will be of service. The botanical name, Eryrhronium, is said to be derived from a Greek word, "signifying red," "the color of some of the species," but this seems to be a very poor reason. This obtains the name of Dog's-tooth Violet because of the long fang-like tuberous roots that are white in color like a tooth. Apart from the lovely flowers the plant produces, the leaves, of the red variety especially, are very handsomely marked. As soon as the ice and snow which hold the earth in bondage in February are dispersed by the warm breath of Spring, it issues forth, first unfolding its handsomely marked leaves, and then its charming flowers, borne singly on stems from four inches to six inches high, and drooping gracefully. The flower is surpassingly lovely, and it comes into bloom with the Snowdrop, Hepatica, and Spriag flowers. A moist peaty soil, with which has been mingled a good deal of sand, appears to suit the Dog's-tooth Violet as well as any. Shady spots are generally recommended for its culture, but it is frequently met with in positions fully exposed to the sun, and doing well. In some localities it appears difficult of cultivation, mainly from the unsuitability of the soil; in others just the opposite results—it flourishes with all the vigor of a native plant. In the midland districts, where there is more humidity pervading the atmosphere than in the South, it scarcely fails to do well. In addition to the imported species, which bears rosy purple or lilac flowers, there are also varieties of it, such as Album, white; Purpureum, purple; and Roseum, rosy. These have been selected, because showing a certain distinctness of color, and have been found to retain it when in cultivation. There is a distinct large-flowering type of the original species, known as Major, in which the leaves and flowers are both larger than is usually seen. The purple-flowering varieties have the green leaves handsomely marked with reddish-brown, and when at their best are more attractive than those of some handsome-foliaged plants that are sold at a high price. The white-flowering variety has the leaves blotched with a kind of whitey-brown color. There is also an American species, E. Americanum, which bears yellow flowers, and blooms a little later in the season. A variety of this is also obtainable, having brown spots at the base of the flowers. It is recommended that every third or fourth year the bulbs be lifted, separated, and replanted."

Pyrus Maulei.—This desirable new fruit has been introduced into England from Japan; it is allied to the Japan Quince. The fruit is the size of a moderate Quince, of a bright apricot-color, and makes a rich conserve. The flowers, which are produced in great profusion, are of a most brilliant orange scarlet color. It is one of the most beautiful flowering trees of recent introduction, as well as a valuable fruit.—*John Saul.*

Phellodenaron Amurense.—A very hardy ornamental tree, flowered last season at the Cambridge Bot. Garden. It has been there fifteen years, so is quite hardy. The plant is diœcious and a native of Maudchuria. It grows in its native places fifty feet high, and has a trunk one foot thick, with a corky bark. It is allied to Ptelea and Xanthoxylum. Prof. Sargent contributes a fuller note on the subject to the April *American Naturalist.*

New Magnolias.—We have from Mr. R. B. Parsons & Son, flowers of Magnolia Lenné, M. Thurberi and M. Halleana. These are varieties—the first of purpurea, and the other two of the Chinese. The Lenné differs from the M. purpurea in having very broad petals. Halleana has numerous, narrow white petals—is in fact semi-double, and Thurberi is a fine petaled variety, more on the cream. In reference to these we have the following note: "I sent you yesterday by mail, a box containing flowers of Magnolia Thurberi, as we named it long ago. Since sending it, Mr. T. Hogg tells me he is under the impression that he bloomed it some time ago under the name of M. stellata. We have grown it about twelve years, and these are the first flowers we have had. It is good as a variety, but not equal to Magnolia Halleana, which with its dwarf habit, small flowers, and fragrance is a great acquisition. This, M. Halleana, we have bloomed a number of years. These Magnolias, with Retinosporas, and other things, we received from Dr. Hall, who was then in business in Japan, and very fond of plants. I hope you will be able to form some idea of the character of the flower."

HOUSE GARDENING is nearly at rest just now. The flowers for winter use are mostly in pots out of doors.

Most of the plants are set out for the Summer, as formerly recommended—little care will be required beyond seeing that they are not over or under watered. Some will be yet growing, and may be full of roots. If growth will probably continue for a while longer, pots a size larger may be furnished such. Whenever a shoot appears to grow stronger than the rest, so as to endanger compactness or any desired shape, pinch it back, and any climbing vines should receive due regulation as they grow over the trellis, or they will speedily become naked below. A good stiff trellis is a desideratum hard to be obtained by the uninitiated.

An important point just now is to prepare Winter-flowering plants. Cinerarias, Chinese Primrose, and Calceolarias should be sown about the end of the month; and cuttings made of most kind of plants that are desirable. It is a great mistake, often made, to store up and treasure year after year old and even grown specimens, when younger ones would bloom more vigorously, and give better satisfaction. Propagation of plants will go on. It is one of the pleasures of the gardening art, and where old treasures are prized, the greenhouse soon becomes a crowded mass of ugliness, with credit to neither gardener nor owner.

Panicum plicatum variegatum.—It is surprising that this, the most beautiful of all variegated grasses, does not enter oftener into ornamental garden work. It does well in partial shade, where few things will, and is excellent for vases or baskets under trees, or in piazzas for Summer adornment. It bears room culture very well also, and comes in well for Winter window work.

Flowering Cyclamens.—We like to make note of good specimens of culture. It would be pleasant to know that some of our readers could beat the following, from the London *Journal of Horticulture:* "Mr. Richard Maries, nurseryman, Lytham, has sent us a photograph of a plant of Cyclamen persicum. The plant, which is in a 7-inch pot, has more than a hundred flowers, and is similar to the plants usually exhibited at the London shows. The plant has never been allowed to become too dry when at rest. Mr Maries considers over drying the cause of much injury in Cyclamen culture. The variety submitted is pure white, and evidently belongs to a good strain.

Permanent Ivy for Boquet Vases.—A pretty fashion is coming into existence of having ornamental flower pots made like boquet stands, and planting ivy therein. In an ordinary boquet stand ivy would not grow, as there must be a hole somewhere to let the water out, or the ivy or any other plant will not grow; but a smaller inside glass is used to hold the water for the cut flowers, and around this is the earth for the ivy to grow in. The effect of the growing border of ivy round the cut flowers is very pretty indeed.

The Beauty of the Eucalyptus.—Some of the Eucalyptus have beauty as well as fragrance. The annual report of the Director of the Melbourne Botanic Garden, in referring to improvements in portions of the grounds, says that several specimens of the gorgeous scarlet-flowering Eucalyptus ficifolia are there planted, and then adds: "This magnificent plant, from Broken Inlet, Western Australia, produces its flowers at a much earlier stage of growth than any other species of the genus with which I am acquainted. Its bloom resembles a ball of fire more than anything else to which I could compare it. I have seen the Flame Tree of Illawarra, and the brilliant scarlet masses of Erythrina laurifolia on the banks of Rewa in Fiji, but neither surpasses the effect produced by the floral display of this Eucalyptus.

Burlingtonia fragrans.—Not only are orchids valued for their rare and singular beauty, but many of them have a delightful fragrance. As the London *Journal of Horticulture* says: "One of the sweetest of orchids is Burlingtonia fragrans: its perfume may be described as that of May blossom intensified. This plant was recently flowering—indeed, it appears to be almost always in flower—in the collection of Mr. Bull, at Chelsea. The plant is growing on a block, and its pendulous racemes of delicate blush-tinted flowers are very attractive. It is a most enjoyable orchid, and worthy of a place in all collections of stove plants."

Maiden Hair Fern.—The *Garden* says: "Some idea of the extent to which Maiden Hair Fern is used in Covent Garden for boquet making may be gleaned from the fact that Mr Rochford, of Tottenham, has several large, span-roofed houses entirely devoted to its culture for furnishing fronds in a cut state. The plants are grown in 12-inch pots, and in order to keep up a regular succession, only a portion of them is cut at a time, those which furnish such fronds being subjected to a lower temperature than the rest, by which means the fronds assume a deeper green color, and last longer after being cut than they otherwise would do."

The kind employed is not specified. In this part of the world the common Maiden Hair, Adiantum capillis veneris, is used to some degree, though not to the extent indicated in the above extract, as in England. But it might be more generally employed than it is. By the way, this is one of the best of ferns to use as a window plant.

Falling of Flower Buds in the Camellia.—Among the peculiar experiences of the year in English gardens, is a remarkable dropping of the flower buds of Camelias, and the papers are busy in discussing the cause. Amongst other papers is an interesting one in the *Gardener's Magazine*. After showing that neglect the Summer before will operate injuriously the Winter following, it say : "It does not follow, however, that the case now before us is to be explained in this way, and we incline to the belief that very many of the collections that have of late disappointed their owners had the best possible attention in the Summer of last year Why, then, should they behave so differently to their wont? Can it be that defect of solar light is the cause of their disaster? We incline to the belief that herein is a sufficient explanation. The later days of the Autumn and the whole of the Winter, thus far, have been characterized by the prevalence of rain clouds; and it is scarcely exaggerating the case to say that in London we have had but three bright days during the past three months. Light is the life of flowers although all flowers do not require equal degrees of light for their full development. The Camellia, indeed, is a shade-loving tree, and we occasionally meet with surprisingly large, healthy, and productive Camellias in old houses that have by long neglect become grass green above, and muddy below and rickety everywhere. The coating of moss and confervæ on the glass, and even the black bars formed by the absorption of dirt in the laps, may be beneficial to the trees in Summer, as affording a little shade, and giving the light the greenish tinge it has in the shade of large trees, where Camellias grow naturally. We should like to know how Camellias have flowered in dirty old houses during the past season, and probably some of our correspondents can inform us. If deficiency of light is the cause of the failure we now deplore the old houses should be in the worse plight, and the newer houses should present a marked contrast in favor of large glass and good carpentry. To know the cause of a disease is said to be half a cure; we cannot dispel the rain cloud, we cannot produce artificial sunshine; but we may reasonably inquire if, in the case of Camellias, there is this season any difference in the flowering of those that are in light and airy houses, and those that are "boxed up" in tumble-down houses where the woodwork is heavy, the squares small, and the glass more or less coated with black soot or green vegetation. While we incline to the belief that lack of light is the principal cause of the falling of Camellia buds, we do not claim that we have disposed of the question. We prefer to place it before our readers, asking them to assist in its solution It is more than a horticultural question, it is one of considerable commercial importance."

New Rose, Queen of Bedders.—A good bedding rose, should above all other good characteristics, bloom freely. Mr. Noble, of England, in the above variety, thinks he has just the thing. He says: "Its inflorescence may be imagined when it is stated that a plant 14 inches high had 84 buds and expanded roses upon it on the 6th of September, 1876, and flowered continuously from June until November, on the 20th of which month (1877) it was still in bloom."

A Double White Bedding Lobelia has originated in Prussia, and is now being offered under the designation of *Lobelia erinus erecta fl. albo plena.* It is said to range from three to four inches in height, to be dense in habit, and to flower abundantly in the open ground; but as yet no opportunity has been offered for determining its value for bedding purposes in English gardens As all the white flowered lobelias that have been introduced up to the present moment have proved worthless, some amount of caution should be exercised in planting this new comer, until it has been subjected to a careful trial; more especially as the double form with blue flowers is of no value whatever in the flower garden.

Apricots in California.—Apricots have been the special pride of the Golden State, but for some reason are said to be very scarce there this year. It would be interesting to know whether the curculio has found its way there yet. We suppose it will get there one of these days.

Three Thousand Varieties of Strawberries.—As showing how easy it is to raise good seedling strawberries, we may say that Mr. Durand, whose name is connected with good varieties, has now in bearing three thousand varieties, which he regards as distinct—but which we should think the "protective committee" at Washington would be hard put to describe explicitly so that any one might know whether he was infringing on a patent right or not—and any one of which would be good enough for ordinary mortals. Such facts as these make the propriety of going into ecstacies over a new and promising variety, very doubtful. If good kinds can be produced in such numbers, we shall soon be in the condition of the new potato men. They raised new kinds for us by the hundred—all of them so good—that there was no great use in selecting any one, and then they took to advertising the seed, so that every one could raise his own best variety. Will it soon be thus with the strawberry?

Apples for England.—So late as the 4th of May, the "Indiana," of the American Line of Steamers, from Philadelphia to Liverpool, took out 1,500 barrels of apples. Some of these were of the celebrated Pennsylvania variety, "Smoke House," which is said to be highly appreciated in England. In past times they seem to have known nothing of American apples except "Newtown Pippin," and seemed to be astonished at the superiority of other kinds.

The Northern Spy Apple in the West.—It is said that the Northern Spy is fast outrunning all other kinds in popularity in Iowa and Michigan. It is longer coming into bearing than most kinds, but generally brings more in market than the others, and this, perhaps, may help balance accounts.

The Gros Colman Grape.—This variety has never achieved great popularity with American hot-house grape growers, but we note that in the December reports of Covent Garden (London) Market, it seems to be the general favorite, and to bring higher prices than all the varieties of that season. What say Mr. Huidekoper and our other friends who are interested in experimental vinery culture?

Size of Pot-raised Pears.—In England the Dwarf Pear is not uncommon as an orchard house fruit. Of some remarkable fruit the London *Journal of Horticulture* has this to say: "Mr. Hawkins, gardener, Ewenny Abbey, Bridgend, Glamorganshire, tells us that he grew last year in pots Pitmaston Duchesse Pears weighing 27 ozs., Durandeau, 21 ozs., and Doyenne du Comice, 17 and 18 ozs., that fruit being of excellent flavor. He wishes to know if other gardeners have obtained fruits as fine or finer."

Sending Peaches to Ireland.—Mr. J. H. Parnell, of Alabama, who did himself so much credit in the exhibition of the very large peaches of the Early Beatrice variety, at the Centennial last year, has astonished the residents in "Great Britain and Ireland" by sending peaches from Alabama to Ireland in a first-rate condition. The Irish *Farmers' Gazette* says they were in just as good condition as if pulled fresh from the tree. Mr. Parnell brought them in a box, which is thus described: "The contrivance consisted of a large, square bin or deep wooden chest, strongly put together, and lined with zinc; within this was another large chest similarly lined, a space of some 8 or 9 inches intervening between the inner and outer chest, which was filled with ice. In the inner chest the peaches were stored, not in separate trays, layers, or anything of the kind, but heaped as you would stow potatoes in a pit; and there they lay, a rosy and happy looking mass, in the best possible condition."

Forcing Asparagus.—The poor stuff called canned vegetables, will never compete with nice fresh ones, just cut fresh from the plant, and particularly is this so with Asparagus; and then it forces so easily. A correspondent of the *Garden* gives his experience, which we give on the principle that what a man says he has done, is worth a whole chapter of "how you may do it:" "Asparagus may be obtained a month before it is ready out of doors as follows: About the middle of February place some movable wooden frames over a permanent bed of it, and with a few barrow loads of warm manure and leaves, make up a lining all round the bed, and cover its surface with dry hay. Then put on the lights and keep them closed for three weeks, when the heads will begin to appear. The hay should then be cleared off; and a little air given on every favorable opportunity. Under this treatment I cut my first Asparagus on March 20, and since that date I have cut several hundreds of beautiful heads, and still they promise to be sufficiently abundant to keep up a good supply until the outdoor crop is ready. By this plan the bed, which does not experience any disturbance, will last a great number of years, provided its produce is not cut too late. Cutting should cease and the glass be removed directly the out-door crop is ready."

[COUNTRY GENTLEMAN.]

THE LIRIODENDRON.

THE tulip tree, or poplar, as it is generally termed here, is one of our most common as well as most useful trees for ornament, shade, and lumber. Within the last decade, millions of fine specimens of this grand tree have been ruthlessly destroyed and cut into the lumber which constitutes the major part of many a cosy home. Timber is no object, and the destruction still goes on; portable mills are plentiful, and in a score or two of years this beautiful specimen of Nature's handiwork will have disappeared from our forest.

It seems most congenial to hilly, broken land, where it attains its greatest size. The valleys and hills of the Ohio and Mississippi seem to be its native home. Wood, in his botanical works, gives an account of a tree 23 feet in circumference four feet from the ground, and 125 feet high, growing in Indiana. Fifteen years ago, when thousands of acres that are to-day in grass and grain were in all their primeval woodland glory, broken only here and there by a small farm, there was a tree a mile or so from my father's house in this county, 10 feet in diameter and 140 or 150 feet high. Alas, the woodman spared not that tree, and this king of all its race has gone the way of all things earthly! Trees four and five feet in diameter are abundant. The kind known as white or blue poplar is very tough and will not split; the yellow kind makes good rails, shingles, etc., and above ground compares favorably with our best lasting woods, but will soon rot in the ground.*

Another feature your correspondent failed to note—and a very important one too for shade and ornamental trees—is that it is one of the earliest to put forth leaves, which quickly grow to their full size. They are now (April 21st) about one-third grown, and already make quite a shade. The leaves are very graceful, dark green, smooth, truncate at the end with two lateral lobes, on long, drooping petioles; are from 3 to 5 inches in length and breadth, and when held in the sun have the appearance of being bronzed, something like the southern magnolia. The flowers in dry weather accumulate several drops of honey on the petals and sepals, and are generally sought after by the average small boy, bees, and animals that have a sweet tooth. Young trees 10 or 12 feet high are often replanted, after trimming the tops, and few die. They grow rapidly from the seeds, and, when left alone, soon make beautiful shade trees.

Henderson County, Ky. WILL A. SISSON.

THE PHOSPHATES.

PHOSPHATIC manures are made from several crude substances; yet all depending, first, upon their content of phosphoric acid. This acid, so important as a plant food, is almost always found in combination with lime, forming a phosphate of lime. And just here it will be well to consider these several forms of phosphate of lime. Phosphoric acid unites with lime in three proportions, viz.: one part acid to three parts of lime, called the *tri*calcic phosphate; one part acid to two parts of lime, called the *bi*calcic phosphate; and one part acid to one part lime, called the *mono*calcic phosphate. The tricalcic form contains the "insoluble" phosphoric acid; the bicalcic form, the "reduced" phosphoric acid; and the monocalcic form, the "soluble" phosphoric acid. These different forms have different values as plant food, owing to the degree of solubility and consequent availability to the roots of the plant. These values are commercially expressed at 12½ cents per pound for the soluble phosphoric acid; 9 cents for the reduced; and 6 cents for the insoluble. The tricalcic or insoluble phosphate is soluble in 100,000 parts of water. It is therefore probable that a portion is available to plants in this form.

The value of a phosphatic manure depends, therefore, not only on the percentage, but also on the form in which the phosphoric acid contained in it exists. And the aim of the manufacturer should be to have the larger portion of this ingredient in the soluble form, as it is for the interest of the buyer to have it in a condition to be readily taken up by the plant.

SOURCE OF PHOSPHATES.

The usual sources of phosphate of lime are bones, mineral phosphates and guanos; in all of which, and in barnyard manure, it is present mostly in the insoluble form. But it should be remarked here that this so-called insoluble phosphoric acid is gradually changed to the soluble and available form, when applied to the soil, through the agency of the carbonic acid of decomposing organic matter. In the case of finely ground bones, for example, it is estimated that about 50 per cent. of its phosphoric acid is used by the crop the first year, 25 per cent. the second year, 15 per cent. the third, etc. For general use, however, the "soluble" form is the most economical; unless the farmer has an unlimited capital, those boughten manures which contain this plant food in an immediately available form are the only ones he can afford to purchase. A manure which only makes a partial return the first year, is like an investment of money making similarly slow returns—safe, perhaps, but less profitable than that which makes a quick return.

MANUFACTURE.

The most prolific source of phosphate of lime is bones, "and the country has been scoured, from the backdoor and swill-tub of the humblest cot, to rendering establishments, battle-fields, and the great western prairies, for a supply of the raw material." Bone fertilizers are found in the market in several forms, ground bone being the simplest. Fresh, raw bones contain an average of 22·50 per cent. of phosphoric acid, or about 50 per cent. of phosphate of lime, and from 3 to 5 per cent. of nitrogen. Bone-black is also largely used as a supply of phosphate of lime. It is the refuse of the bone charcoal used in the refining process at refineries, and contains from 32 to 34 per cent. of phosphoric acid, the nitrogenous portion having been driven off by the burning.

All manures, to be most efficient, must have a fine mechanical condition. This is always obtained in well manufactured fertilizers. Bones have other value than for manure, however, and before being used for this are usually subjected to a steaming and reducing process to remove the fat, etc., for other purposes. This also helps to render part of the phosphoric acid soluble. The residue—and the same for bone-black—is treated with sulphuric acid, in the proportion of 63 parts of the latter to 100 parts of the tricalcic phosphate contained in the bone. These are the theoretically proper proportions, but in practice less sulphuric acid is used—about one-half—on account of the expense; which accounts for the fact that only a portion of the phosphoric acid in the fertilizer is found in the "soluble" form. The sulphuric acid unites with a portion of the lime of the tricalcic phosphate, leaving the remainder in combination with the phosphoric acid, "soluble" and readily available for plant food. We shall speak hereafter of the home manufacture of superphosphates. The term "superphosphate" of lime means the same, chemically, as "monocalcic phosphate," above described, but is applied indiscriminately to any fertilizer, the principal ingredient of which, in value, is phosphoric acid.

MINERAL SUPERPHOSPHATES.

Bones, though at first the main source, now furnish but little of the phosphoric acid of fertilizers, so great has been the demand for phosphatic manures. To supply the deficiency, the vast beds of mineral phosphates, so called, prove to be deposits of great aggregate value. The chief of them are located in Central Russia, Western Germany, Southern France, Canada, South Carolina, and in the Navassa, Sombrero, Jarvis, and Baker Islands. The Navassa and South Carolina deposits are now the main sources of supply. It has been estimated that four-fifths of the superphosphates manufactured in this country are now produced from the two last-named sources. The Navassa contains from 32 to 36 per cent. of phosphoric acid, the South Carolina from 24 to 27 per cent. Though so rich in this ingredient, it is all in the insoluble form, and owing also to the extreme hardness of the substance, it is manipulated with difficulty. Though ever so fine, sulphuric acid acts but slowly upon it; due to its hardness, and also to the presence of carbonates of lime, magnesia, alumina, and oxide of iron. The entire absence of nitrogen and potash from this class of superphosphates, makes them of value chiefly to use in connection with barnyard or other manure containing these indispensable ingredients of an effective manure. Some superphosphates are manufactured from the real mineral phosphates, Apatite—the above being the mineral remains of the deposits of sea birds, etc. The insoluble phosphoric acid of the superphosphate made from Apatite is held by Professor Goessmann to possess little if any appreciable value, because of the compact nature of the rock containing it, though the soluble portion is as good as any.—*Scientific Farmer.*

ON EXTIRPATION OF INJURIOUS INSECTS.

By ANDREW MURRAY, F.L.S.*

I PRESUME it is unnecessary for me to inform any one present that this meeting has arisen out of a letter addressed by the President of the Privy Council to the different agricultural societies throughout the kingdom, covering a copy of a communication that I had made to my Lords, recommending steps to be taken for the extirpation of insects injurious to agriculture, etc. That communication was simply a letter drawing attention to the amount of damage done by insects; to the fact that isolated action was powerless against them; while in many cases their extirpation, or, at least, a great reduction in their numbers, might be effected with ease by combined action; and recommending that my Lords (as the department more especially connected with agriculture) should make a tentative experiment with that object. Anxious not to injure my proposition by making too bold or radical suggestions, I timidly limited it to one or two garden pests peculiarly open to attack, and to three counties—Lancashire, Derbyshire, and Cheshire—that had something of a peninsular or semi-isolated character. The reply of my Lords was, that though they were of opinion that it did not fall within the province of the Science and Art Department (to which my communication had been officially addressed) to take action in the manner suggested by me, yet they felt that the subject was one which well deserved the consideration of agricultural societies in the United Kingdom, and that to them copies of my letters would be sent.

* Read before the Society of Arts.

The reply is somewhat Delphian in its utterance, and may be read in more ways than one. To some it may seem to be merely a civil way of shelving a difficult question, and others may regard it as an invitation to the societies to favor them with their opinion on the subject. This is naturally the interpretation that I put upon it. It seems to me to say, that I have either not applied to the right department, or the right branch of the right department, or have not suggested the right remedy or the right mode of its application; but that, if deemed by those most interested to be of sufficient importance to call for the intervention of my Lords, they would then be willing to take up the subject, with the view of providing a remedy in the right way and through the right department.

It is with the view, then, of obtaining the opinion of those most interested in the subject that this meeting has been summoned, and having been asked to open the discussion with a paper, I propose to take advantage of the opportunity to examine the subject from some points of view which I did not touch upon in my previous letter. I feel that the weak part of that communication was the tentative remedy that I suggested. It was only touching the fringe of the evil. I shall now regard it from a more extended point of view, and endeavor to show how it may be dealt with in a more comprehensive and efficient manner.

I begin by making one or two assumptions, which I presume will be granted me, but which, if disputed, can be easily proved. I assume that, besides the occasional great injury done by insects, by which whole districts are ravaged, a continual drain is constantly kept up by them which constitutes a very perceptible percentage of deduction from the cultivator's profits. I say that much of this is preventable, and I assume that, where it can be prevented at less cost than the loss occasions, it should be prevented.

So far, I imagine, we must all be at one, but we may not be all at one as to the possibility or means of prevention, or at least of prevention except at a price greater than the loss that would be sustained by leaving matters as they are. I do not mean mere money cost—that would be easy to deal with, for whenever you come to actual figures you can cipher them out, but I mean the interference with a man's liberty of action in conducting his own business. That is the critical point of this question. How far it would be wise, and under what precautions it would be desirable, for the general benefit to interfere with the inalienable privilege of an Englishman to do what he likes with his own. None of us are so Quixotic as to maintain that there are no bounds to this right—but as a body, Englishmen are pretty decided in their aversion to paternal government; and, before accepting any proposition tending in that direction, they would require not only to be satisfied that the object was really for the general interest, but also that it can be attained in no other way. That the object is for the general interest is one of the assumptions that you have permitted me to make, and that it can be attained in no other way than by entrusting power to some executive authority (it matters not whether that authority be the actual government or another government instituted for the purpose) will be plain, if we consider for a moment the nature of the work contemplated. If we wish to rid a district or a country of an injurious insect, and if, as is very generally the case, we have the power of doing so by attacking it at a particular date, and in a particular manner, it is obvious that, to be effective, the attack must be simultaneous and combined, for to what purpose would it be if I cleared my farm while my neighbor did not clear his, or if I cleared mine one year and he cleared his another? We should each preserve an ample reserve of our pests to replenish the cleared fields of the other. A central authority, therefore, a power to which both he and I and every other farmer in the district, must bow, is needed to secure united action, and what is such authority but paternal government, compelling us to obedience for our own good?

As to the advantage of the general principal of stamping out, and the necessity of an executive authority to direct it, there cannot, therefore, be much difference of opinion, but there remains the more difficult question, how much and what kind of interference may be tolerated, and by what safeguards it should be surrounded, and how far it is workable or not? The administrative machinery by which it should be carried out need not concern us. If government resolve to interfere, it must fall to them to make their own plans, but as a contribution towards elucidating the various points which they would have to consider, I think I may usefully draw the attention of the meeting to a few of the different ways in which interference might be beneficially exercised.

The simplest, the most powerful, and the most efficient of these is what I may call county or district rotation of cropping. Farmers know well enough the advantage of a rotation of cropping (or its equivalent) on their own farms. By long-continued growth of the same crop on the same land the soil becomes exhausted of some of the elements necessary for the proper development of that kind of crop, and a change of crop brings other elements into use, and relaxes the demand upon those that have been too much drawn upon.

Exactly the converse of this takes place with regard to certain insects. The great majority of vegetable-feeding insects do not feed on all kinds of plants indiscriminately; most of them are restricted to one kind of plant, and if by cultivation of that plant its numbers are enormously increased, so will naturally be the number of the insects that feed upon it, while, if we should cease to grow that plant, the number of the insects would correspondingly diminish. Thus, for instance, if a district is almost entirely in pasture, there will be very few wheat-feeding insects in it, but if it is turned into a wheat country, they will be in myriads. If these numbers reach such a pitch as to deteriorate the crops, the remedy is plain. Change the rotation, and grow some other crop instead of wheat. Allow me to illustrate this by an actual example. There is nothing like a real instance for bringing a fact home to our minds. Last summer I spent the month of July at Broadstairs. In my rambles about the place I was immediately struck with the wheat crops. At a little distance they looked tall and strong, but on examining the ears I found them so ill-filled that I should have said they were only three-quarters filled. The blade or leaf was throughout almost entirely white and dry, and I have no doubt that if I had asked any farmer what was the cause of the poor ears he would have said drought, as shown by the bleached and dried-up leaves. Mr. M'chi informs me that this is what is commonly known as blight; but there may be more than one kind of blight, and blight from more causes than one. I shall, therefore, not stand upon its name; whether it be blight or not, it seems to me plain that, if the farmer's assumption that the bleaching of the leaves was due to drought had been true, his conclusion would have been quite right. It was the deficient action of the leaf that stayed the flow of nutriment to the ear. There is not much fear of the farmer making a mistake upon this point. He, at least, ought to be (or, if not, he is not master of his craft) perfectly alive to the fact that, if you want a good crop of any kind, you must have abundant and healthy foliage. Try to grow any plant, and see what kind of crop you will have if you constantly deprive it of its leaves. But, although he would be quite right in describing the deficiency of weight in the ear to the failure of the leaf, he would, in this instance, have been wrong, in ascribing the failure of the leaf to drought. It was due to the mining of the larva of a small fly, named *Agromyza graminis*, which lays its eggs under the skin of the leaf at its tip. From thence the young larvæ mine downwards, feeding on the parenchyma of the leaf, leaving nothing behind but the empty husk, consisting of the upper and under walls of the leaf. If the leaf is small, they entirely consume the interior; if large, they may not reach entirely to the bottom of the leaf, but will have consumed about three-fourths of it before they pass into the pupa state—as may be seen from some leaves which I have preserved, and which I hand round for examination. The diagram shows this, and the place where the insect lies is indicated by a darker spot. Now, of course, I cannot tell what amount of damage this insect did. Had I guessed that I was likely to be now reading a paper about it to the Society of Arts, I would have got the ears dried and weighed, and endeavored to give chapter and verse for a specified proportion. But not having done so, all I can do is to leave those who are familiar with the subject to work it out for themselves, merely premising that almost every blade in the whole district seemed attacked. Still, for the purpose of my next point it is necessary for me to make some estimate of the proportion of loss. I have said that the ears seemed only three-quarters filled. They continued so until reaped. Let us suppose that this is too much by half, and take an eighth. This would give a loss of upwards of 12 per cent. on the grain crop, and to make the margin still wider, and the figures manageable, let us reduce it to 10 per cent. The actual percentage of loss is not of much consequence if I can satisfy you it was considerable, and my object is less to show the amount lost than where it falls.

Now we all know that the total yearly produce of a farm has to be distributed between three accounts—one is in repayment of the cost of cultivation; another is in payment of rent; and the third is the tenant's profit. It is plain that no reduction can be got either from the expenses of cultivation or the rent on account of this insect damage. The tenant or cultivator has to lose the whole of it, and you will also see that although the loss on the whole crop may be only 10 per cent. that is by no means the percentage of the loss on his profit. Ten per cent. loss on the whole crop means, of course, 30 per cent., if all thrown upon a third of it. If, for example, we suppose that the tenant's profit on the entire produce is one-third, and that the total gross produce of the wheat crop was £500, 10 per cent. loss on that is £50, but 10 per cent. loss on the tenant's profit would only be £16, whereas a deduction of the whole £50 would be equivalent to upwards of £30 per cent. You will thus see that this, in its present stage, is entirely a cultivator's question. The landlord (not a cultivator) has only a prospective interest. If arrangements could be made by which such insect damage could be annihilated, no doubt, as leases terminated, a readjustment of rent suited to the improved production would take place, but in the meantime it is the tenant who suffers, and who will be the first benefited by stamping out such insects.

Now a change of crop, if carried out over a sufficiently wide district, supplies an easy and effectual cure for the attacks of this insect. Its habits lend themselves to such a remedy. It feeds only on wheat and a few allied pasture grasses. At Broadstairs there were crops of barley and crops of wheat growing side by side, the only separation between them being a footpath, not two feet in width, running through the field; and while, as I have said, every wheat blade was mined, I could not find one touched on the barley, which, by the way, had correspondingly escaped damage. Furthermore, the insect is only an annual. If it could be banished for one year it would be banished entirely, or until reintroduced. Now if there were a controlling authority in that district, what would be easier than to say to farmers, "Gentlemen, in the common interest you will substitute barley for wheat in your next year's rotation." The fly, deprived of its proper nidus, must then either lay its eggs in an unsuitable place, where they will perish, or have recourse to the pasture fields for *Triticum repens*, or other suitable grasses. By this, of course, the fly would not be exterminated, but its numbers would be so reduced as to render it comparatively harmless, at all events, for a time, when, if it again reappeared in force, the same means of defence could be again resorted to. Nay, it might be so arranged that two or more counties might brigade themselves togetner, so as to establish a permanent see-saw, by which they should play into each other's hands. But you will observe that no single man can carry out such a rotation. He may try it upon his own fields, but they will be replenished continually from the fields of his neighbors, unless they at the same time are compelled to follow the same rotation. Gentlemen, it is for you, who know the respective capabilities of soils, and the relative returns of wheat and barley, to say whether you would prefer to suffer a heavy yearly percentage of loss, or to submit to the substitution of barley, or some other crop, instead of wheat for a single year.

And if you thought it desirable to do so, can there be any difficulty in carrying it out? Are we so uninventive and destitute of resources that we cannot contrive some means by which the necessary power should be put in action? I could suggest half a dozen ways. Power might be given to the Lords of the Privy Council to carry it out at their own discretion and *ex proprio motu;* or to carry it out on the requisition of the county authorities; or on a requisition of a committee of the farmers of the district, appointed for the purpose of dealing with insect pests and similar questions; or on the initiation of the agricultural societies of the district; or an inspector might be appointed for every county, with the requisite power and authority; or a central board of experts might be appointed for the same purpose, but with wider jurisdiction; or each county might have a board for itself. Any man can plan out a scheme for it, but I think no man will maintain that there is any insuperable difficulty in devising means that will answer the purpose.

Before leaving this point, let me remind the meeting that the plan of excluding for a year a particular crop from the cultivation of a district will apply to almost every crop that we grow, whenever the insect is an annual (that is, does not live over one year), and this includes by far the greater number of injurious insects.

The next means of extirpation to which I shall advert is burning the nidus in which the insect, in whatever stage, passes the winter, and I may take as my example the species of a small fly belonging to the genus Chlorops, which specially attacks barley, although it also sometimes attacks wheat, rye, etc. The larva makes a channel in the stem of the ear, causing abortion of the pickles, and gives it a stripped looking appearance (as shown in the diagram), which, on a superficial examination, might be taken for the work of sparrows. The fly remains about the ear for many weeks after it is thrashed, and may be found in great numbers in winter in a semi-torpid state among the chaff. Now, is it not an intolerable abuse of the privilege of doing what a man likes with his own, that my neighbor should be allowed, for the sake of the small profit he can make out of his chaff heap, to preserve such a focus of infection to destroy my future crops? He should be compelled to burn it. In like manner we want some one to compel the burning of the heaps of couch-grass and weeds gathered from foul land, instead of keeping them to rot into manure. These are the focus and shelter-place of wire-worms and other pests, and contribute largely to their spread.

To the same class of remedies belongs the local treatment which I recommended for the onion fly. The plants attacked are readily distinguishable from those that have escaped—the former are sickly, flaccid, and yellow, the latter firm, erect, and green—and those attacked can easily be picked out and burned. Each plant attacked contains a nest of larvæ in the stem or bulb, as shown in the diagram. If these are destroyed the whole future family are annihilated. The carrot plants attacked by the carrot fly are equally easily distinguished and destroyed—but it is not certain that the grubs in them always keep to the same root. But both with them and similarly destructive insects that infest the cabbage and turnip, a year's avoidance of that crop throughout the district will relieve it from them.

Now comes the remedy, in the shape of some application that is fatal to the insects. This is the plan adopted in America for the destruction of the Colorado bettle, where Paris green is dusted in powder or sprinkled in solution over the larvæ on the potato plants. It is the plan used by our horticulturists to get rid of the red spider in their hot-houses, where sulphur is the medium. Manufactured into Gishurst compound, or made up into some soapy solution, sulphur is also largely used by them to destroy green fly. Sulphur has also been successfully used on a small scale against the hop fly, and might be advantageously used on a large scale. There are various other supposed specifics (such as hellebore for the gooseberry caterpillar, etc.) which are more or less in favor with different individuals. As a remedy, however, such applications seem better adapted for individual protection than combined stamping out, although it would be foolish to forego the advantage of using them where they seem to meet the requirements of any special case. Such a case most certainly is the destruction of what are called ticks and lice upon sheep. Every one knows how readily such vermin can be communicated by contact or even proximity, and it does seem a very hard case that a man, who has kept his flock clean by taking proper precautions, should be liable to have them infected by a neighboring neglected flock, by stray sheep, or even by sheep passing along the road. I have no personal knowledge on the subject, but I am told that, *cæteris paribus*, the difference in value between a sheep that has been kept clean for the season and one that has been worried by vermin will be 20s. If that is so, I wonder that sheep farmers have not long since clamored for some supervision.

The picking and gathering of the individual caterpillars, or perfect insects, is a remedy that has been tried largely on the Continent, but without any marked success. For ordinary crops it is much more clumsy than a change in the rotation, and for crops which cannot be so dropped out of rotation, as fruit or forest trees, it is almost impossible to collect the larvæ efficiently. At the same time it is right to add that this *échenillage*, or caterpillar collecting, can scarcely be said to have ever (any more than any other plan) had a fair trial, it having been generally conducted without regular system or combined and simultaneous action over a wide extent of country.

There remains the last refuge of all invaded countries, namely, destroying the resources of the country before the invaders, that they may perish for want of food. This can rarely be necessary, but beyond doubt it will be the proper course to follow should the Colorado beetle gain a footing in this country. In that event, the first that we shall hear of it will be that the larva has appeared in some potato patch near Cork or Londonderry, Liverpool, or Glasgow. The instant this is perceived, the vines of the potato field should be cut to the ground, and Paris green scattered over the field.

But this is not a course that can be adopted, even in a case of such urgency and importance, unless there is some central motive power having the necessary authority to act; for the notice that the Colorado beetle will give will be very short. The larval stage, in which alone it can be successfully encountered, only lasts about a fortnight, and, if no previous preparations have been made, I leave any one who knows the slow grinding of our administrative mills to say what chance there is of the larva having grown big enough to be noticed; of somebody having noticed it and reported it; of the report being considered and a course of action resolved on; of officers or agents being appointed to act; of their providing the necessary apparatus; and of their reaching the spot and putting them in operation—all within the short space of fourteen days.

I have nearly exhausted the list of my suggestions, but there is one which I must not forget. It is very small, but, in my view, very important. If you erect a great pump, with costly steam engine and machinery, and omit to put in a fang, all your pains and expense will be abortive for want of a little bit of leather. So here: power may be given to the Privy Council; you may have your committees and officers all ready to work as soon as an insect appears; but they may sit expectant and useless from one year's end to the other, unless some one comes and tells them that the insect has appeared, and where it is. They are exactly in the same position as the firemen and fire engines of our fire brigades. There they are at every station, horses, men, engines, fire escapes, and everything ready to start at a moment's notice, but of what good would all this readiness be if no one came to call them? and if they left it to chance, or to the owner of the house on fire, they might never be called until it was too late. What they do is not to trust to that, but to offer a reward to the first person that brings news of a fire. It is only a trifle that they give, but it answers the purpose. Let us follow their example by all means, call on the cultivator to give notice as soon as an injurious insect appears in any numbers on his farm; but do not trust to him. Promise a reward to the first person who shall communicate the intelligence of such a pest appearing. There are more entomologists scattered about the country than you think of. It may be that you would have some erroneous and some false reports, but proper precautions against deception could be taken. Specimens of the insects might be required to be

forwarded; and even although some deception and cheatery did take place, it could be endured. The fire brigade does not cease to offer its reward for first notice, although some incendiaries have set places on fire for no other purpose than to claim it.

The above are suggestions relating to the machinery by which the extirpation of injurious insects might be effected. There remains another point which, supposing you to go in the main along with me, must also be considered, and that is, what the action of this Conference should be in regard thereto. If I might offer an opinion, it humbly appears to me that its office is rather to give a general verdict upon the importance of the subject and the practicability of dealing with it than to enter into the discussion of details which should more properly be left to the Government, who will be responsible for them should they resolve to deal with the subject. I have had to enter into details for the purpose of making my meaning clear to you, but I hope I have not committed myself to anything beyond general principles. On these I own that my opinions are very decided. I believe that no one has any adequate conception of the amount of loss that agriculturists suffer every year from insects. I cannot give any statistics on the subject because there are none. But although I can give you no statistics, we have the evidence of our own eyes for the existence of a vast amount of preventable loss. I know that it has been said that any attempt to control insect damage is visionary and unworkable. To some men everything that is troublesome or difficult is impracticable. But I am speaking to men whose boast and character it is not to make difficulties but to conquer them, and it is for them to say whether there is anything in the views I have had the honor to lay before them that is either visionary or unworkable.

ON GROUND-AIR IN ITS HYGIENIC RELATIONS.*

By DR. MAX VON PETTENKOFER, Professor of Hygiene in the University of Munich.

THE air in the ground has been somewhat a stranger to our minds; the terms air and earth, just like air and water, implied to our minds things contrary, and exclusive of each other. The earth seemed to have its limit where the air began. Common sense seems inclined to believe that there can be no air in that whereon we walk and stand. If we say of the surface of the earth that it is the limit of the earth and the beginning of the atmosphere, we are not correct in reference to the latter. The air begins much below the ground, and we ought to say that where the ground, which is a mixture of earth, water, and air, ends, from there the atmosphere exists alone. It is no wonder that no particular attention was paid to the air in the soil; its presence there does not make any direct impression on any of our senses; we infer its presence more from

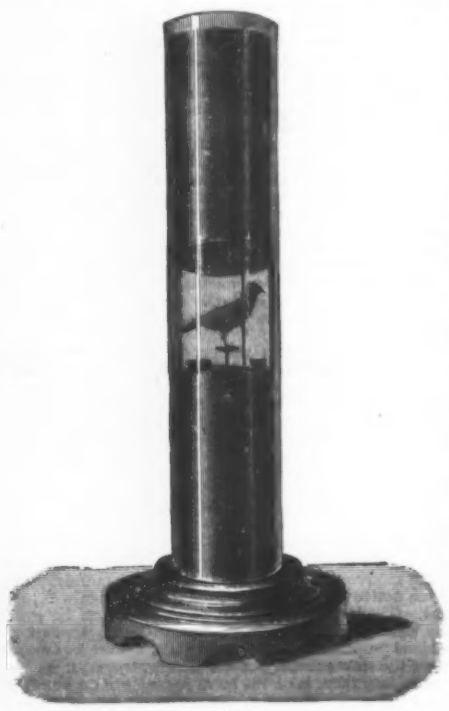


FIG. 1.

other experiences and consequent conclusions. The human mind formerly looked upon the air as something unsubstantial, spiritual, although men saw the effect of hurricanes; no wonder, then, that no one thought of the air hidden in the ground, which cannot even blow the hat from our head.

We again meet here with the fact that, originally, only that calls forth ideas which impresses our senses directly. No one doubts that water penetrates the soil, and moves there according to hydrostatic laws, because we see it run, vanish into the soil, collect and run out again, or we pump it up; but hitherto not many have clearly understood that the whole surface of the earth, as far as it is porous and its pores are not filled with water, contains air, which is also subject to aërostatic laws. And why so? One feels nothing of that air: it is always calm, it has no color, no smell, no taste, in fact we take it for nothing. I have shown you already how great an error we commit when we suppose a calm air to be motionless. This applies just as much to the air in the soil, which, if its motion were even snail-like, would still travel from a good depth to the surface in one day.

Perhaps I shall succeed in giving you a better idea of the change of the air in the ground than of that in walls. To have a correct idea of that air and its relations, we must know, in the first instance, its quantity in proportion to the different kinds of soil. Let us first take rubble-soil, gravel, or sand, which support the largest and heaviest edifices. Here is a bottle which holds exactly one litre ($1\frac{3}{4}$ pint) up to that mark on its neck. I have filled it slowly with gravel, shaking it all the while, so that the gravel settled completely. The gravel reaches up to the mark. This high cylinder contains just one litre of water, and is graduated into one hundred parts. Now I pour the water into the gravel, till I find it just coming up to its surface, and I see that of the water in the cylinder thirty-five parts have entered the gravel and driven out the air, which before had therefore taken up thirty-five per cent. of the whole mass. This is certainly a great quantity of air, and if we build a house on such a ground its weight rests, no doubt, on the gravel alone, and not on the air; but for all that, this ground, as far as it is dry, consists to the extent of one-third of air. In building on gravel, we build as well on air, just as we build on water when we build on piles driven into a swampy soil and cut off under the water. We know well that a house standing on piles stands with its foot in water, that this water is drawn up by the walls till beyond the water-mark, that the water of the ground has a good deal to do with the house; why should we, then, refuse to acknowledge that the foot of a house built on dry gravel, stands also on the air, and that the air in the ground is in intimate relation with the house?

What I have shown you in regard to gravel, can, in a similar way, be proved in regard to sand, clay, and even more solid stony and rocky soils.

Most kinds of sandstones are nearly as porous as loose sand. The rock of Malta has been proved by Leath Adams to suck up water on an average to one-third of its volume; consequently, when dry it must contain air to the same extent. One would not think that this was the case with the rugged cliffs and shores of that remarkable island, which look as if they were built from the granite of the Swiss Alps. Most buildings in Malta are built with this Maltese rock, which is much used also throughout Italy. It is not less porous than the Berlin sands; their penetrability for air and water is the same, but the grains of the Maltese rock are connected by some solid medium, while the grains of the sand are loose. In respect to their porosity they stand relatively as frozen and not frozen soil.

Many ships of the English navy have filters made of a certain kind of Maltese rock. I have tested one, and I have found that the filtering basin swallows forty-seven per cent. of its whole contents, when used for the first time.

A soil whose pores are filled partly by air and partly by water is called damp. It can take up more water till all its pores are filled with it, when all passage of air is stopped, just as we have seen with regard to the mortar of the house. That degree of humidity of the soil is called *ground-water;* it begins at the lowest limit of the air in the soil.

It is well known that water becomes solid at a temperature below freezing point. In becoming ice it changes its consistence totally, but its volume not very much, increasing it by about six per cent., one hundred volumes of water becoming one hundred and six of ice. In a frozen soil, there must have been a certain quantity of water. This water in freezing has become a kind of cement for the particles of the soil, and gives it a solidity which the liquid water could not impart. Although such frozen soil is as hard to work as stone, we have no right to assume that it is impermeable to air or gases of any kind.

Those pores of the soil which were free from water cannot be narrowed much by the expansion of the neighboring pores through the freezing of their water. It would be just as incorrect to deny the permeability to air of the frozen soil as that of the Maltese rock. Still, the most erroneous views have been formed on this subject, even by men distinguished in other branches of science.

Having given you an idea of the quantity of air in a porous soil, I have to give you a correct idea of the mobility of this air and of its change, and I shall try to do this in a roundabout way, as I cannot do it by direct impression on your senses.

There are things of whose existence we become only aware when they are absent. Probably the fish is as little aware of the water he lives in as we of the air, till he finds himself on the dry land. The creatures living in the air know nothing of its oxygen, but, when we place them in an atmosphere which has none or too little of it, or too much carbonic acid, they will feel and behave like the fish out of water. There is a difference in a want of oxygen betweeen different animals; birds want a good deal proportionately. A canary bird takes about one and a third cubic inch of oxygen from the air in one hour. In one litre of air there are about thirteen cubic inches of oxygen, which the bird would have consumed in ten hours. But he would be dead long before, as he could not live in an air deprived of one half of its oxygen. The bird in this glass cylinder has been shut up between gravel for the last ten hours, and you see he is quite well. The cylinder is shut at its lower end by a wire netting, on which a stratum of gravel rests. The bird stands on the gravel, and above him there is another wire netting, which supports a stratum of gravel. The free space for the bird contains about one litre of air.

This bird is shut up in the same way as workmen sometimes are, digging at a well or at some kind of shaft. If accident does not kill them at once, they seldom die from want of air, even if it takes some days to dig them out, although man's consumption of oxygen is about a thousand times as great as that of the canary bird. Some years ago, in Saxony, two men who were shut up in the shaft of a well for ten days kept alive and were not much the worse for it when they came out again. I may mention here that the celebrated Fraunhofer, when still apprenticed to a glazier at Munich, was buried for several days under the ruins of his master's house, which had fallen in.

I expect Fraunhofer's luck will be shared by this bird, whom I intend removing to-morrow to his old cage.

You cannot longer have any doubt about the motion of the air through gravel; but I want to convince your senses; I want you to *see* the motion of the air, and to *see* that motion take place through a much thicker stratum of gravel than the strata shutting in the bird.

You see this high glass cylinder (Fig. 2), with a smaller glass tube inside, open at both ends. The cylinder is filled with gravel, and the glass tube connected with a manometer by some india-rubber tubing. As soon as I blow gently on the upper surface of the gravel, you see the liquid in the manometer moving. The motion of the air which I produce acts in the first instance on the surface of the gravel, propagates itself through the same to the bottom of the cylinder, enters the lower end of the tube, rises through it and through the tubing into the manometer, where it presses on the column of liquid, and sets it in motion.

Why does the liquid move in the manometer? Because the air, after the migration just described, presses with greater weight on the surface of the column it arrives at than the outer air on the surface of the other column. If there were no liquid in the manometer, the moved air would finally flow out of the manometer, and, as you see, now that I have emptied the manometer, nearly blow out this candle.

In this way I believe that I have convinced your senses that the air can move through porous soils.

If the air in the ground can be set in motion by the pressure of air or wind against its surface, there can be no doubt that the same can be effected by differences of temperature, and by diffusion, and generally by all causes which can produce movement of gases. As long as the air in the ground is of a different temperature or composition from the free atmosphere, there must be exchange and motion. I

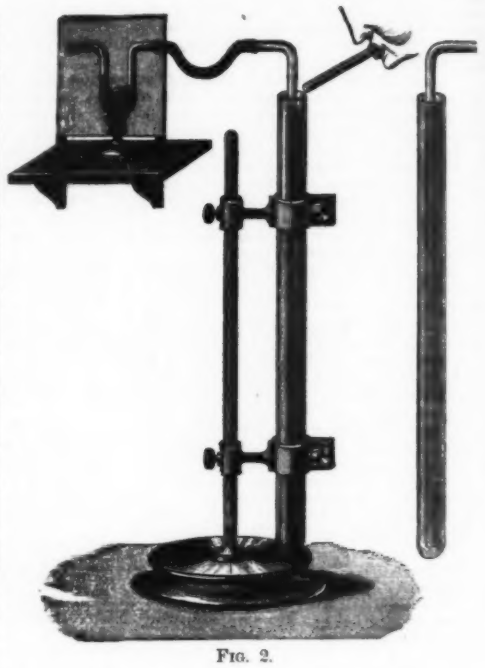


FIG. 2.

will only, in order to leave no doubt on your mind, direct your attention to several well known facts, which can only be explained by the change of the ground-air.

All Christian nations bury their dead in the earth, to give back to dust what came from dust. There are burial grounds in which a corpse decays completely in six to seven years, and others in which it takes twenty-five to thirty years. The regulations about a second occupation of a ground depend on this difference, and therefore towns with an equal population may be obliged to have burial grounds of very different sizes. There are other circumstances of some influence on the process of decay, but the principal one is the amount of, and the facility for, the change of the air in the soil. Rubble and sandy soils do the work much quicker than marl and clay soils. Striking experiences in this respect have been made on the French battle fields, chiefly near Sedan, where a Belgian chemist, Louis Creteur, had to disinfect the large dead pits. The bodies were buried in chalk, quarry, rubble, sand, argillite, slate, marl, or clay soils, and the sad work lasted from the beginning of March to the end of June. In rubble the decay had taken place fully, but in clay the bodies were surprisingly well kept, even after a very long time, and even the features could be identified.

As the processes of putrification and decay are intimately connected with the activity of certain lower organisms, which prey upon the dead, it is sufficiently clear that these organisms must thrive differently in different kinds of soil. A lively change of air and water in the ground appears to be of great influence in this respect; the more air in the ground the richer the underground life.

Remarkable testimony as to the permeability of the ground, and of the foundations of our houses, has been given by gas emanations into houses which had no gas laid on. I know cases where persons were poisoned and killed by gas which had to travel for twenty feet under the street, and then through the foundations, cellar vaults, and flooring of the ground-floor rooms. As these kinds of accidents happened only in winter, they have been brought forward as a proof that the frozen soil did not allow the gas to escape straight upward, but drove it into the house. I have told you already why I take the frozen soil to be not more air-tight than when not frozen. In such cases the penetration of gas into the houses is facilitated by the current in the ground-air caused by the house. The house, being warmer inside than the external air, acts like a heated chimney on its surroundings, and chiefly on the ground upon which it stands, and the air therein, which we will call the ground-air. The warm air in the chimney is pressed into and up the chimney by the cold air surrounding the same. The chimney cannot act without heat, and the heat is only the means of disturbing the equilibrium of the columns of air inside and outside the chimney. The warm air inside is lighter than the cold air outside; and this being so, the former must float upward through the chimney, just like oil in water. It continues to do so long as fresh cold air comes into its neighborhood from outside. As soon as we interrupt this arrival, the draught into the chimney is at an end. Any other way of looking at the action of chimneys leads to erroneous views, which have many times stopped the progress of the art of heating and ventilating.

Thus our heated houses ventilate themselves not only through the walls but also through the ground on which the house stands. If there is any gas or other smelling substance in the surrounding ground-air, they will enter the current of this ventilation. I have witnessed a case in Munich, where not the least smell of gas could be detected in the street, but a great quantity of gas found its way into the ground-floor room of a house where no gas was laid on. In another case the gas always penetrated into the best heated room and produced an illness of its inmates, which were taken with typhoid fever.

The movement of gas through the ground into the house may give us warning that the ground-air is in continual intercourse with our houses, and may become the introducer of many kinds of lodgers. These lodgers may either be found out, or cause injury at once, like gas; or they may, without betraying their presence in any way, become enemies, or associate themselves with other injurious elements, and increase their activity. The evil resulting therefrom

* Abridged and translated by Augustus Hess, M.D., member of the Royal College of Physicians, London.

continues till the store of these creatures of the ground-air is consumed. Our senses may remain unaware of noxious things, which we take in, in one shape or another, through air, water, or food.

We take rather a short-sighted view all the while, when we believe that the nuisances of our neighbors could only poison the water in our pumps; they can also poison the ground-air for us, and I see more danger in this, as air is more universally present, and more movable, than water. I should feel quite satisfied if, by my lectures, you were convinced of this important fact, if of none other.

England has given proof how the public health can be improved, by keeping the soil clean through good drainage, abolition of cesspools, and abundant water supply. It would carry me too far if I were to analyze now to which of these measures the lion's part belongs; I should have to enter upon many controversies, which I have no time to fight out in this place; but this is my conviction, which I want to impress upon you, that cleanliness of the soil and diminution of organic processes in the ground of dwelling houses are most essential.

Many have considered these processes, and their effects on ground-air, to be a mere hypothesis. This view now lies behind us, and facts have been found proving their reality. Stimulated by the investigations of Huxley and Haeckel, further researches have followed, and shown that not only at the greatest depth of the sea, but also in every porous soil, there are everywhere those beginnings of organic life, belonging neither to the animal nor vegetable kingdom, mucous formations, which are called Moneras and Protistes. When I wrote my part of the report on the cholera in Bavaria, in 1854, I pointed out already that the air, not less than the water in the soil, ought to be drawn into the circle of experimental investigations. Neither others nor myself acted at once on my suggestions, and it is only during the last eighteen months that I have examined the ground-air in the rubble-soil of Munich, regularly twice a week, for its varying amount of carbonic acid. The results are surprising, and for the future I shall have to trouble others and myself, not only with ground-water, but also with ground-air.

The place where the examination of the ground-air of Munich is being carried on is rubble, without any vegetation, and the carbonic acid increases with the distance from the surface. Agricultural chemistry has been aware, for a long time, that a clod of arable earth which is rich in humus is a source of carbonic acid, but no one expected that, at times, so much carbonic acid should be meet with in sterile lime rubble. A few feet under the surface there is already as much carbonic acid as in the worst ventilated human dwelling places.

I have found that the quantity of carbonic acid is smaller at fifty-eight inches than at one hundred and fifty-six inches throughout the year, the months of June and July excepted, when an inverse proportion arises. But then there begins also, in the lower stratum, a considerable increase, so that the upper stratum soon finds itself behind again. This large quantity of carbonic acid in the ground-air of Munich has been far surpassed in Dresden. Examinations have taken place in that town under the authority of the Central Board of Public Health. Professor Fleck's diary proves that, at least at that spot where his examinations took place, the quantity of carbonic acid was in winter already nearly twice as great as in Munich in the month of August. I might become jealous of Dresden, but we must often, in life, put up with being left behind, although we had the first start, and I have no choice but to resign myself.

The presence of carbonic acid in the soil and its periodical motion are for the present a bare fact. Other places, with different soils, must be examined under varying circumstances, and for longer periods, before an explanation can be attempted.

The first question which naturally meets us is that about the origin of this gas. It cannot spring from the humus of the surface, because at Munich and Dresden its quantity is smallest in the immediate neighborhood of the surface, where the humus lies, and increases in proportion to the distance thence. As the amount of carbonic acid in the ground-air generally increases the nearer this is to the ground-water, we should be at first sight inclined to assume that it evaporates from it. Is it not a fact that the ground-water which feeds wells and sources contains this gas? And is it not well known that many a well's shaft contains so much carbonic acid as to extinguish a burning candle at the distance of a few feet only from its opening? This assumption, however, is not justified for several reasons, according to the researches and experiments made at Munich: 1. There are two months in the year when the amount contained in upper stratum, which is at the greatest distance from the ground-water, is larger than in the lower. 2. I have examined simultaneously, at given places, the amount of the gas both in the ground-water and in the ground-air, and have investigated whether, according to the laws of diffusion and absorption, either had a surplus of the gas, and was accordingly in a condition to receive or yield some of it. In every case the amount of carbonic acid in the ground-air was larger by fifty per cent. than in the ground-water, so it is clear that it is the water which receives its carbonic acid from the air, and not *vice versa*.

Hereby the question about the origin of the gas is certainly not yet answered, and would have been left equally unsettled if we had to ask, Whence comes all the carbonic acid which is found in the water? All this water is precipitated from the atmosphere, from rain or snow. In entering the soil as meteoric water its amount of carbonic acid is exceedingly small. By help of Bunsen's analytical tables it is easy to calculate, from the quantity of carbonic acid in the atmosphere, and the absorbing power of water for this gas, that one pint of rain water at the average temperature and barometrical pressure can only contain a very small fraction of a grain of carbonic acid, and this has been proved further by analytical experience. But the analysis of the pump water in Munich which was poorest in carbonic acid showed that it contained on an average $1\frac{1}{2}$ to $1\frac{9}{10}$ grain of the free gas. The ground-water at the places of examination stands about sixteen feet from the surface. It is therefore evident that the meteoric water, which is the sole source of the ground-water, must more than centuple its original amount of carbonic acid before it reaches the wells. This much is certain, that the source of the carbonic acid must be sought for in the soil, and for this reason the more natural supposition is, that the soil yields the gas and gives it to the water and to the air simultaneously, but naturally with greater facility and in greater quantity to the air than to the water. The sources of the carbonic acid in the soil have now to undergo a stricter investigation; the probability is, they owe their origin to organic processes in the soil.

METALLOTHERAPY.

A REPORT has been presented to the Biological Society of Paris by the committee appointed to inquire into M. Burq's method of treating certain affections by the application of plates of metal to the skin. For some time M. Burq has asserted that, in some states of defective special or general sensation, sensibility may be restored by the application of metals, the special metal required being a matter for experiment. The metal being found by external application, it can be safely administered internally if it is considered desirable. The investigations of the committee have been carried on for the past six months in the wards of the Salpêtrière, under the charge of Prof. Charcot, who was, of course, a member of the committee appointed to report upon the phenomena. The patients experimented on have been chiefly those affected with hysterical hemianæsthesia or hystero-epilepsy. In these cases sensation is lost to such an extent that not the slightest reaction is exhibited, even when long needles are thrust through and through parts usually the most sensitive. Colocynth may be placed on the side of the tongue, and the most disagreeable odors held to the nostril, without exciting the slightest appearance of sensation or reaction. As regards sight and hearing, the loss on the anæsthetic side is not usually complete, but considerable, there being no signs of organic disease in the retina or the ear. The temperature is also found to be lower on the anæsthetic side, and the muscular power, as tested by the dynamometer, considerably impaired. The committee have found, in accordance with M. Burq's statements, that there exists in different patients a special susceptibility to metals, and that sensibility does return under the influence of a certain metal. This is determined by bending on the arm or leg, or anæsthetic part, plates of gold, copper, zinc, &c. After from ten to fifteen minutes it is found that, if the metal employed be the proper one, sensation begins to return at the point of application. When the metal is applied to the forearm the sensibility gradually extends to the hand, and the temperature rises above that of the other side, as determined by a theremometer fixed in each hand. At the same time the muscular power rises very considerably above that which existed before the commencement of the experiment. By the application of the metal at or near the organs of special sense a more or less complete restoration is effected, but unfortunately it is only transitory, the anæsthesia speedily returning. The most remarkable phenomenon appears to be that the return of sensibility, under the influence of the metallic plates, is effected at the expense of the sensibility of the sound side. Thus, if the sensibility be restored to the arm by the application of the metal, it is found that the corresponding part of the sound arm has lost its normal sensibility. The committee have not yet ascertained the effect of the simultaneous application of the metals on both sides of the body, but experiments have been made on two cases of hemianæsthesia of cerebral origin, and it is remarkable that in these two cases the recovery has been permanent and not transitory, as in the hysterical cases. M. Burq's statements having thus been confirmed, the committee endeavored to ascertain the *modus operandi* of the metallic plates. It having been suggested by several members of the society that the results were due to electrical action set up by contact of the metals with the skin. M. Regnard was intrusted with the experimental testing of the hypothesis, and he succeeded, with Du Bois Reymond's galvanometer, in demonstrating the fact that the contact of the metals with the skin did actually excite electrical currents, which varied with the metal employed. Thus, the plates of gold caused a deflection of the needle of from 2° to 12°, while similar plates of copper caused a deflection of from 40° to 45°. This being established, currents of a like intensity from a galvanic pile were employed, and found to produce effects analogous to those caused by the application of the metals. In patients sensible to gold a current of from 2° to 12° caused a restoration of sensibility, but in those sensible to copper a current of from 40° to 45° was necessary. A further interesting fact came out in the course of these experiments—viz., that a patient sensitive to a current of 10° to 15° ceased to be sensitive to a current of 45° to 60°, but again became sensitive to a current of 80° to 90°. Such is a brief *résumé* of the facts, and we need scarcely say that the investigations of the committee have been watched with curiosity and interest by many medical men and biologists; so that, now M. Burq's hypothesis is established, further research will, it may be hoped, lead to more important discoveries.—*English Mechanic*.

SURGICAL TREATMENT OF A HORSE.

THREE weeks ago a gentleman of this city purchased a fine, high-bred mare in Boston, and as she was being led to the station in that city she became frightened, and started at full speed, coming in contact first with a horse-car and next with a doctor's chaise, and fell with great violence upon the pavement, receiving a severe bruise upon the top of the head, which would not heal. A Prussian physician, well known for his love of the equine race, was consulted. Upon careful examination of the wound, he was satisfied that some foreign substance was keeping the wound open, and, in order to remove it, it was necessary to make a large incision. The foreign substance was found to be a part of the skull, fractured and driven in upon the brain, the piece being about as large as the first joint of a man's thumb. This was removed by a strong pair of dental forceps, and it was found necessary to chip off with a small chisel and mallet other small points of injured bone, and also to remove with a large file the rough edges of the wound, in order that the wound might readily heal. When the larger piece of bone was removed a small part of the brain came out also. What appears the most remarkable in this case, the animal made not the slightest resistance, but kept perfectly quiet, except a slight nod of the head when the chisel was struck. It appeared as if she thoroughly comprehended what was being done for her relief. The animal is now recovering.—*Providence Journal*.

PHYSIOLOGY.

Pasteur on Splenic Fever.—A very important contribution to our knowledge of the relation between the organisms discovered by Davaine in the blood of bovine animals suffering from *charbon* and the other phenomena of the disease has just been published by Pasteur and Joubert (*Comptes Rendus*). Koch had already discovered the curious fact that the rod-like organisms in question were capable, under certain conditions, of breaking up into minute spores, instead of multiplying, as usual, by fission; these spores, in their turn, undergoing development into rods when kept under observation in serum or aqueous humor. Pasteur and and Joubert, by taking a small quantity of blood from an affected animal, under the precautions necessary to guard against septic contamination, and introducing it into various liquid media, succeeded in cultivating the specific bacterium without any admixture of foreign organisms. Absolutely pure urine, rendered neutral or feebly alkaline, was found to be the most convenient liquid for its cultivation. When such urine is inoculated with a minute quantity of the infected blood, a flocculent mass of interlacing filaments makes its appearance in it within twenty-four or twenty-eight hours, the rest of the fluid remaing perfectly translucent, and presenting no trace of septic microzymes under the microscope. By using a drop of this urine for the inoculation of a fresh sample, and repeating this process again and again, it is possible to obtain any number of successive generations of bacteria derived from the original stock; and—this is the all-important point—the most remote descendants of the original organisms, bred in urine for a period of months, retain their specific infective power, and give rise to the disease when introduced into the body of a healthy animal. Hence it is absolutely certain that the infective properties of the blood in splenic fever do not depend either on the rod corpuscles or on the leucocytes contained in it, for these are all of them eliminated in the course of the successive cultivations in urine. The possibility of some soluble virus being reproduced side by side with the organisms was next taken into consideration. By filtering the urine in a particular way, the bacteria were separated from the liquid in which they were suspended; and the filtered liquid alone was found to be incapable of generating the disease when inoculated. Analogous results have been obtained by previous inquirers; but, owing to the numerous sources of fallacy by which all researches of this kind are surrounded, they have never met with unreserved acceptance. The justly great authority of Pasteur may be expected to produce a deep impression on the minds of many who have hitherto kept their judgment in suspense.

On the Color of the Normal Retina.—Continuing his researches on this subject, Kühne finds that the coloring matter is not uniformly distributed throughout the retina (*Centralblatt für die mediz. Wiss.*) In the human eye, and in that of *Macacus cynomolgus*, the posterior surface of the yellow spot and *fovea centralis* is colorless. In the immediate neighborhood of this region, where the cones are more numerous than the rods, the red tint is comparatively feeble. Just behind the *ora serrata*, too, there is a narrow zone absolutely devoid of color; in the human eye this zone is two millimetres in width; in that of the ape one millimetre. The eyes employed in the research had been shielded from the light for many hours before their removal, and were hardened in a solution of alum.

Helfreich's assertion that the red color of the retina may be seen with the ophthalmoscope, under suitable conditions, in the eye of the living rabbit, is questioned by Dietl and Fleck (*Centralblatt*) on the strength of the following experiments: A rabbit, kept in a dark room for several days, was rapidly deprived of blood by section of one carotid artery. Warm milk was then injected through the other carotid, till it escaped without any appreciable tinge. (These operations were performed by yellow sodium-light.) On ophthalmoscopic examination, the fundus was seen to be perfectly white; no details of structure could, however, be made out. The vessels were once more filled by injecting blood into the carotid artery, and the capillary plexus of the choroid resumed its normal aspect, no extravasation having taken place. The eyeball was now excised and the retina examined within fifteen minutes; it was still of a rosy-red hue, such as it usually presents in eyes which have been long protected from the light.

Influence of Sleep on the Activity of the Kidneys.—It has been ascertained by Prof. Quincke (*Archiv für experimentelle Pathol. und Pharmakol.*) that, whereas the urine secreted during sleep is scanty and of high specific gravity, that secreted during the first three hours after waking is more abundant and of lower density than during any similar period of the twenty-four hours. A number of observations were made to establish this point, the subject remaining in bed, and taking neither food nor drink for the three hours in question. The fact admits of being interpreted in various ways. We may suppose the absorption of fluid from the intestinal canal to be arrested during sleep and resumed on waking. This hypothesis is a most unlikely one; for the periodic variation takes place as usual when no liquid has been taken within four hours of retiring for the night. It is probable that the physiological activity of the kidneys may be checked during sleep, owing partly to diminished energy of the secretory nerves, partly to contraction of the renal blood-vessels, partly to a lowering of tension throughout the arterial system. This is the most probable explanation; but it is still in need of proof.—*Academy*.

PHOTOGRAPHIC PRINTING PROCESSES.

By C. BAUMANN.

ALTHOUGH it was reserved for the last decade to bring the photographic printing processes to a rather high degree of perfection, the effort to make photography in this direction useful and profitable is almost as old as our young art itself. Many able men have undertaken the solution of this problem, and, as a consequence thereof, having produced more or less favorable results, I think it important enough to give a compilation of the different methods employed. Before I do this it will be necessary to classify them, those where a print can be made from the original plate forming one class, while those where this is not the case form a class of themselves. We have, therefore, two classes, one comprising the *direct* method, the other the *indirect* method.

To the direct method belong—

1. Fizeau's heliographic process. 2. The Aubel process.

To the indirect method pertain—

1. The different asphaltum processes. 2. Lichtdruck. 3 and 4. Relief print and Talbot's steel-print process. 5 and 6. Photo-lithography and photo-zincography. 7. The heliographic processes.

The indirect processes having been, so far, more generally used, we will begin with them:

1. *Asphaltum Processes.*—If a proper solution of asphaltum (*i.e.*, asphaltum dissolved in oil of lavender, ether, or chloroform) is poured upon a metallic plate or stone in a dark place, and the surface, dried in the dark, is exposed to light under a negative, the parts touched by the light will become insoluble; if the particles remaining soluble are now removed with benzine or oil of lavender, the underlying surface will be exposed, and the possibility is offered to let acid operate upon the thus exposed parts of this surface. In this way an engraved plate is produced which is suitable for printing.

Nicephore Niépce made his first experiments in this way to obtain a picture in the camera, but he seems to have had no success with it. His nephew, Niépce de St. Victor, however, was the first successful one to complete this method. The last named exposed an asphalted steel plate under a positive, dissolved the unchanged particles with benzine, and etched the remaining parts with acid.

Negré exposes to light a steel plate under a negative, gilds, in the galvano-plastic manner, those parts exposed by washing with benzine, cleans the asphaltum entirely from the plate, and etches it with acid, the parts not gilded only being touched. One of the heliographic methods (that of Baldus) is also partly based upon the properties of asphaltum, as we will see afterwards.

2. *Lichtdruck* (*Light Printing*).—If a coating of glue soaked with chromate of potassium is exposed to light under a negative, amongst other properties obtained after treating the coating with warm water will be the one upon which lichtdruck is based—that is, to receive only and fasten upon the lighted parts, correspondingly with the lighting, more or less ink. If now the coating, impregnated with printing ink and covered with clean paper, is put through a proper press with a slight pressure, the ink—that is, the picture—is transferred completely upon the paper. This method comes from Albert in Munich (therefore called Albertypy), but was practised about the same time by Obernetter and Gemoser. Presuming that the details of this method are sufficiently known, I restrict myself to this brief notice.

3 and 4. *Relief Printing and Fox Talbot's Steel Printing Process.*—Chrome gelatine plays again the principal part in these processes, but this time another property of it being used—by light to become indissoluble in warm water. If, therefore, a lighted chrome gelatine coating be treated with hot water, those parts that have become insoluble by lighting remain, whereas the soluble, unlighted parts are dissolved, and the coating does not now appear smooth, but is more or less etched. This etched surface was used by Woodbury, the inventor of the relief or Woodbury print, as a mould, to make by means of a hydraulic press a copy in metal. A thin coating of warm pigment (a mixture of coloring matter and gelatine) is poured upon this metal plate, and a sheet of paper pressed upon it lightly. The ink adheres to the paper, stiffens at once, and the picture with all its half-tones is completed. With any other ink no half-tone can be obtained, because the gelatine ink has solely the property to look lighter in thin coatings than in heavy ones. The results obtained in this manner are quite excellent.

Fox Talbot exposes a steel plate covered with chrome gelatine under a positive, having dissolved the unlighted parts with warm water; etches the exposed parts of the steel plate with acid, chloride of iron, or chloride of platinum; and obtains in this manner a deeply-etched drawing of the same.

5 and 6. *Photo-lithography and Photo-zincography.*—Niépce had already tried to transfer the photograph on stone, and created, by means of the asphaltum process, a picture upon it, and etched the same into the stone. Poitevin coats a stone with chrome-gelatine, because the ink will then stick to the lighted parts. Others make, by the last method, first a picture upon paper, transferring the paper picture, which has been inked, afterwards upon stone, which, by this manipulation, will be adapted for printing.

To obtain a zincograph, a picture is pressed upon zinc in the last-named manner, and etched, first with very dilute acid, and afterwards several times with a stronger solution. To prevent the raised parts from being corroded by the action of acid, care is taken to put powdered resin on them, and then heating the plate just sufficiently to melt the resin. The resin will run over the edges, and protect the sides in such a way that the raised parts remain broader towards the lower side.

7. *The Heliographic Process.*—The object of heliography is to get a printable copper plate. If the plate has been obtained, by a precipitate of copper, from a copper solution in the galvano-plastic method, the plates may also be called galvanic. An etched copper plate is obtained in a simple manner by coating it in the dark with chrome gelatine, and exposing it to light under a positive or negative. After the picture has been developed with water, the parts not lighted will be etched by a solution of chloride of iron. A relief picture is obtained, if a positive is used for lighting, and an intaglio one by using a negative.

Pretsch and Poitevin spread upon a glass plate a mixture of chrome gelatine and iodide of silver, and expose the same under a positive. After developing with warm water an uneven surface (coating) remains, which is filled up with a solution of gutta percha. When dry, it is removed carefully from the gelatine coating, and the gutta percha mould, covered with graphite, serves now for the production of a galvano plastic copper plate.

Baldus uses an asphaltum coating on copper, and exposes the same under a positive. After developing with oil of lavender, the plate remains for a few days under the light, to be exposed afterwards, in a trough with a solution of sulphate of copper, to the influence of a battery. A relief or intaglio picture is formed according to the plate hanging on the negative or positive pole: and while in the first case the copper is deposited wherever the plate is freed from asphaltum, in the other case the copper is eroded. Scamoni, whose heliographs belong to the best productions of this kind, prepares his plates in the following manner: Of the negative to be reproduced he makes a positive silver picture on plate-glass, and strengthens it well with a silver and pyrogallic acid solution. The plate, washed with water containing some ammonia, is after this strengthened with bichloride of mercury, and afterwards with a chloride of gold solution. After this, he strengthens the plate with water containing iron and pyrogallic acid, and dries the same over a lamp. Through this strengthening process the coating has been rendered well in relief, and is in condition to have a good printable copper cliché made from it by the galvano-plastic process. For this purpose a thin varnish is flowed over it, on which, before it is entirely dry, a little powdered graphite is thrown, to give the coating the necessary preparation for the conductor. The plate is now placed into the galvanic bath, and left in it until the copper precipitate has the necessary strength. If the copper plate is now carefully separated from the silver coating, nothing remains to be done but to clean and block the copper plate to use it for printing purposes.

Herewith the indirect methods are concluded, and only the direct methods left for discussion. One of them,

Fizeau's Heliography, has been of but little value, for the plates produced could stand only a few prints; but it is deserving notice, because the experiments which Fizeau and others made with it date back at least thirty years. The idea was to get a printable plate by treating a Daguerreotype with diluted acid.

More important than this method is the latest of all—

The Aubel method.—If liquid or gaseous fluoric acid is left to act upon glass, the acid dissolves the surface of the glass plate to a considerable degree; but while the liquid acid leaves the surface even and transparent, the vapors make the affected parts matt. If liquid fluoric acid is put upon a common varnished silver negative (an unvarnished coating tears too easily), and is left to act upon the same for a few minutes, it will be found, after entirely washing off the silver coating and drying the plate, that the picture, although weak, is completely etched upon the plate. A relief picture has been produced with those parts protected by the silver not affected, or very little, while the unprotected parts have been etched considerably more. If the attempt is made to rub lithographic ink upon such a plate, which appears to be etched deep enough, it will be found that the ink does not stick. If you let fluoric acid set upon an unvarnished, clear negative, strengthened with silver and pyrogallic acid solution, it will be found that a picture has been formed just as before, only with the difference that the affected parts are matt. If, now, lithographic ink is rubbed upon such a matt etched picture, it will be found that the ink adheres, and that it is possible to print the same as on paper. Still those experiments are not always successful, for the reason that the collodion film is apt to tear before the picture is etched deep enough, a consequence of which is that the acid acts over the entire plate. To prevent this, Aubel precipitates, by the galvano-plastic process, a little more silver on a pretty strong negative fixed with cyanide of potassium. The coating becomes so consistent by this manipulation that it will stand the following operation of etching with fluoric acid gas. After the gas has taken effect sufficiently, the silver coating is washed off, and the plate dried and put upon a lithographic press for printing, where it is fastened upon a lithographic stone. The lithographic color is put on with a ball, and is a very difficult manipulation, as is also the printing. For that reason the first good and satisfactory print is transferred upon metal or stone by the well known process, and from these the prints are made.

The entire process is a very difficult one, and claims a great deal of attention, the plates being of no use if they are etched too much or not enough, and will take too much or too little ink. A cleanly-etched plate-glass negative looks charming, but it is advisable, on account of the danger of fluoric acid, that only those should busy themselves with etching who are conversant with it.

As seen from the above process, the results obtained must correspond exactly to the negative, with reference to the position of the several lines, for which reason the process is adapted to the reproduction of line drawings, etc. Half-tones cannot be produced, which explains why Aubel prints appear so hard and dry in comparison to the reproduced original. It may be that by the use of gelatine ink better results will be obtained.

In conclusion, I will remark that of all cited methods for the reproduction of half-tones, two only are suitable, the Lichtdruck process and the Woodbury process; all others give no half-tones.—*Photographische Monats Blatter.*

CARVED PANEL ORNAMENT FROM STALL IN ST. GILES' CHURCH IN BARTFIELD. HUNGARIAN, 1505. (*From the Workshop.*)

PHOTOGRAPHIC SOCIETY OF FRANCE.

PRESSURE FILTER.

M. COMTE, a very old and distinguished member of the Photographic Society of France, presented an apparatus which, if not new, will render great service to many who find a difficulty in filtering syrupy liquids. No. 1 represents a bottle of any capacity whatever. No. 2 an india-rubber stopper having two holes, No. 3 a glass funnel with a tuft of cotton wool. No. 4 an india rubber air-ball. No. 5 a stopcock. The solution to be filtered is poured into the funnel. The air-ball is pressed, taking care to open the tap, No. 5. The latter is closed, and the elasticity of the india rubber ball draws a certain quantity of air out of the bottle. The atmospheric pressure then acting upon the surface of the liquid in the funnel forces it through the filtering cotton, and thence into the bottle.

PHOTO DRYING CHAMBER.

Mr. Harrison, Jr., has presented to the Society the model of a new drying chamber for the desiccation of carbon tissue, gelatine emulsions, and dry plates. Fig. 1 represents a side view of the apparatus. At the lower part is a sheet-iron bottom, No. 1, which, being heated by a spirit or gas lamp, the cold air entering at No. 2 is warmed by passing over the hot plate, and follows the direction of the arrows until it makes its exit by the chimney at No. 3. Fig. 2 represents the front of the apparatus. A B C D are the shelves upon which the objects to be dried are laid. The door No. 3 is closed. This door, pressing against the shelf B, closes the communication and compels the air to take the direction of the arrows, as seen in Fig. 1.

VEGETABLE GELATINE.

A very interesting presentation was made to the Society by M. Stenfort. This gentleman, in pursuing his botanical studies, discovered that certain seaweeds, after having been dried and finely pulverized, could be redissolved in water, and that the product, when poured upon a sheet of glass in the same manner as collodion, and allowed to dry, would give a very tenacious film, and replace with advantage the ordinary gelatine. "If," said he, "539 grammes of the pulverized seaweed be taken and dissolved in 15·400 grammes of water, and then poured upon a sheet of talced glass, a very solid film will be the result. This film can replace with advantage the lithographic stone for fatty-ink impressions, and for the carbon process it will be of great value." A great advantage, in my estimation, which this vegetable gelatine has over the other consists in its not being so easily acted upon by atmospheric changes as the ordinary gelatine. It appears that it takes and holds all kinds of dyes with extraordinary tenacity; but I must confess that it has not the fine appearance of the gelatine as sent out by certain manufacturers. Naturally, as this is a very recent discovery, there is time for its improvement. At present its clarification presents great difficulties, but no doubt these will soon be overcome. The specimens laid before the Society were of divers colors. Some were printed upon, and others were employed as transfer sheets. The whole of them were very tenacious, and more of a leathery appearance than other wise.

PROVING THE COMPOUND NATURE OF WHITE LIGHT.

MR. WM. TERRILL'S method is to arrange seven lanterns, in the first place, so as to project their several circles of light side by side on a white screen, then to color each circle by introducing slides of glass stained to imitate the seven colors of the spectrum (the proper intensity of color being found by trial); we thus get seven circles on the screen colored from red to violet and arranged side by side. Then by turning the several lanterns so that the projected circles shall exactly overlap each other we get one circle of white light, proving that the seven colors together make white light.

The same effect can be produced with five colors only if properly selected; and even two, the ordinary cobalt blue and deep orange, will nearly do. If these two last be made to partially overlap the effect is very striking.